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THE DIFFERENTIATOR—JULIAN HUXLEY.

DISCOVERY

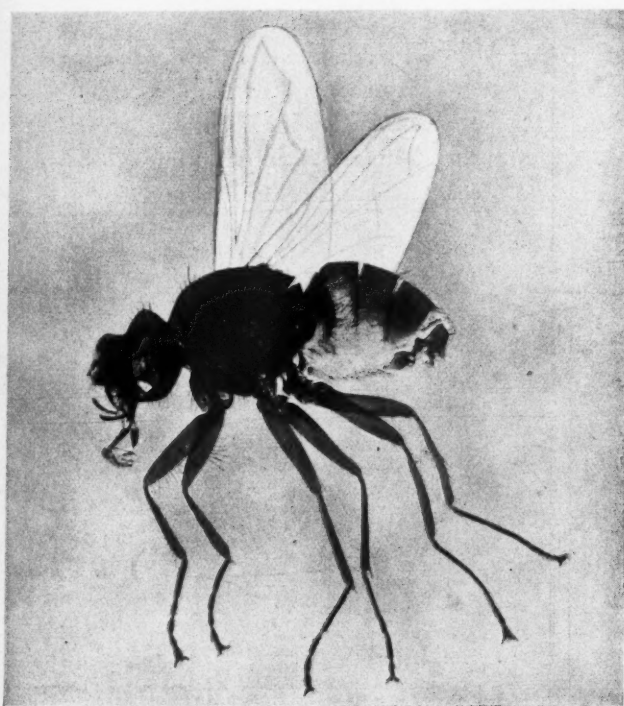
A Monthly Popular Journal of Knowledge

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THE CHILD SLAYER.

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course of pure science may be interrupted by a high explosive bomb and once again our full brain power may be needed in the field of self-preservation, rather than in that of self-realisation.

* * * * *

After the war there was a very natural reaction, and for a while all matters dealing with warfare were automatically tabooed. We, who went through the war did not want to think about them. It was a past nightmare, a horror at long length over. Well, action and re-action are equal and opposite and to-day we live in a world which is rapidly recovering from war-psycho-sis and able to think with less intrusion of emotional hysteria.

* * * * *

Editorial Notes

At Wembley in the H.M. Government Building you may be examining the Royal Society's exhibits when your ears are assailed by gunfire and a recognisable smell of powder. This interruption is by grace of the Lords of the Admiralty who are showing the Raid on Zeebrugge in the theatre below.

* * * * *

Incidentally, it is one of the best things to see in the Exhibition for it is as clean and brave and as heartening as one of Newbold's sea poems. We have reason to be proud of the Zeebrugge fight as one of the magnificent episodes one associates with the British Navy, and the Admiralty are showing their little representation of it in a way that it should be shown. Not showman's stuff, not flashy effects that obscure an epic, but just the right balance of fact and illustration.

* * * * *

Yet there is a moral to be drawn from it. The scientist above, engrossed in his own particular field cannot but be conscious that while he watches the repetition of an experiment, these echoes of mimic war below, but parallel the uneasy condition of the world situation as we see it to-day. At any moment the

Nobody wants war, but the old saying of "Put your trust in God—and keep your powder dry" has not lost virtue because modern high explosives are less hygroscopic than they were in Cromwell's time. The chances of war are not quite as remote as benevolent people would desire. And, although we, as a nation, do not start wars, one of the responsibilities of having our Empire and being near the Continent of Europe is that we get dragged into them. Some of the finest military brains in the country, I do not mean retired colonels or fire-eaters, but the real first-class military intelligence which is in its way a specialised scientific product, put the contingent possibility of another "great" war, and struggles between modern civilised or semi-civilised powers are bound to be "great" wars, as from three to seven years from now. Let us hope they are wrong.

* * * * *

This is a matter of opinion. Many things may happen which may postpone or as likely expedite a crisis. Still—What are we doing now?

* * * * *

"The War Office is fully aware that the development of gas appliances is engaging the attention of various foreign countries, and the protection of our civil popu-

lation against enemy gas attacks is receiving consideration." Mr. Walsh, Secretary of State for War in Parliament, 20 May, 1924.

* * * * *

A bomb has no politics and no sense of class distinction. It also fails to discriminate between the uniformed private and the most eminent of civilians. But there are of course extremist elements who would dislike money to be spent on safeguarding the soldiery, but who cannot object to these measures being taken on behalf of civilians. Fortunately, both classes will benefit and as many civilians will again be soldiers, it is a political rather than a real distinction. These surface differences sometimes obscure a great deal, but it is an excellent omen that though the War Office is traditionally supposed to be a stronghold of re-action, Mr. Walsh representing a Labour Government is not only personally enormously popular but is regarded by everyone in touch with him as in every way a sound man for the job. This is not politics. It is simply a reassuring fact from the ordinary citizen's point of view.

* * * * *

Now when the last war ended mushroom Departments and Ministries were disbanded, and to the outer world it seemed as if the whole vast national fabric of defence was scrapped piecemeal. In a sense it was, yet the germ or rather nucleus of each cell has been preserved and is on record. If need be, the nation can get into action once more in a fraction of the time it took to build up the machinery of the past.

* * * * *

War in its very nature cannot limit itself to defence alone, but the problems of defence against attacks meant to destroy civil morale need the most serious consideration. Science must no longer be called in as an eleventh hour resource but must be in authority from the beginning, functioning no less in peace time than in wartime.

* * * * *

To a large extent this is being done and the scientific staffs both of the Royal Academy and the Research and other branches at Woolwich include some of our very best men. It is a necessary thing, although it is in a way a regrettable thing, but the lesson of all past inventions and discoveries heralded as making war impossible or intolerable has been that the indomitable bravery of man and his capacity for endurance of horrors has always been underestimated. War went on.

We are living, and not entirely unhappily most of us, in what Mr. H. G. Wells has described fitly as the "Age of Chaos." The golden age of the Victorians, that temporary and illusory period of security has passed. So long as unstable conditions continue we must study gas and anti-gas measures, seek the advice of research chemists, and even borrow the knowledge of astronomers to work out the ballistics of long range gun projectiles whose trajectory may reach almost to the limits of atmosphere. Can we reconcile it with the abstract scientific conscience? Well, it would seem that these applied sciences alone can insure the pure science worker those conditions of peace and security essential to his work. To borrow a familiar phrase from the backs of omnibuses—"Safety First"!

* * * * *

Last month I asked readers to define for themselves the average reader of DISCOVERY. The response has been immediate, gratifying and in many cases extraordinarily helpful as indicating the class of article in general demand. The majority of cards and letters embody almost the same phrase: "— an educated and inquiring mind."

* * * * *

One very interesting fact emerged and that is that all our articles appeal strongly to some of our readers and that none of our readers appear to object to the equally good articles which do not happen to appeal to them personally. This is splendid, for when one considers the range of the paper it is manifestly impossible for any one number to contain an article on all the possible subjects which we must pass under review. Nor indeed is it any easy task to obtain a sufficient number of the right kind of article of the high standard we require.

* * * * *

Look through this issue and consider what a range we cover, Biology, Psychology, Geography, Physics, Geology, Eugenics, Archaeology, Physiology—all sorts of sciences are presented under one aspect or another, and these articles are topical and up-to-date, being in their very nature a record of recent discoveries, actual news of progress and contemporary research.

* * * * *

The fluctuating fortunes of the paper are now stabilised and I would ask readers who are in sympathy with the objects of the paper to use their personal influence to extend its range of readers. There are any amount of people who would like DISCOVERY who do not yet know of its existence, and the more support we get, the better we can make the paper.

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A Scientist's Ride in the Dead Sea Desert.

By Cyril Crossland, M.A., D.Sc., F.Z.S., O.N.

The scene of the day's ride is on the west shore of the Red Sea in latitude 21° N., within the peninsula of Rawayā. This is easily found in most atlases, under various spellings. The village from which we started, if marked at all, is generally given as Dongola. To prevent confusion with Dongola on the Nile the slightly more correct name Dongonab has been adopted; the sound l often replaces n in the native Hamatic language.

I WAS so deeply absorbed for years in work on the Red Sea coast and coral reefs that though often looking longingly at the wild mountain ranges beyond the ten mile wide maritime plain, I very rarely enjoyed a scramble among them. Indeed, my feet had rarely been upon any rock of the solid earth; coral, even when elevated above its level, is of the sea, the desert sands and gravels are of wind and rain floods. So when I heard that my friend the geologist proposed to come from Khartum for an exploration of the plain and foothills, I joyfully decided that a few days' holiday would not only be excusable but to the eventual benefit of Marine Biology.

There are deserts and deserts, that of the maritime plain of the Red Sea is not quite the perfect desolation of the desert of Egypt, for its depressions carry water for a few hours, not once a year, but say once in three years, and bear thorn bushes (*acacia tortilis*), and in some few highly favoured spots other species of this wonderful genus. In the more open sandy water-courses are bushy, broom-like Euphorbias, a corky-barked Asclepiad and grass. *Such* grass! Tufts of grey brown sticks like slender bamboo, and like it branched. After rain these put forth rather more flexible branches, with absurdly small leaf blades, grey rather than green in colour, which support the goats, sheep and camels, which in turn enable their nomad masters to support a life which only they could find worth living.

No Oases.

Oases of palms, with bubbling springs are a stock feature of the popular idea of deserts. They are found elsewhere, it is true, but not on the Sudan coast. In their place are muddy wells, almost invariably defiled by dung blown in while dry, and worse than this, by salt. However, it was Spring, and Spring in the desert is as glorious as the Summer is hellish. (I would avoid this common expletive if any other word were as truly descriptive). On certain days when the wind being in the north is dry and not so strong as to drive the sand, the brilliance of the air glorifies every common object, the mountains, all rosy at sunrise later show their purples, reds and browns

with every rock distinct until as the sun descends towards them they are clear shades of violet against the gold of the sky.

My friend's provisioning for a day's riding and scrambling is solely internal! He carries nothing with him, neither food nor water, which are with the baggage animals and inaccessible during the march. Tea between 5 a.m. and 6 a.m., ditto between 5 p.m. and 6 p.m., dinner 7 or 8 p.m.; a simple life, a prospect which I viewed with dismay! Spring in the desert may be exhilarating, but it is a good deal hotter than summer in England and the evaporation is proportional to the exhilaration! "Maleish, I'll try your plan" said I, and found it worked.

Endurance Needed.

So about 5.30 a.m. having had tea I mounted my camel and made for the well a couple of miles inland, over the plain of salt-hardened blown sand, the gravel rise with its dusty acacias to the depression of baked mud in which my friend camped. Then on together through an area of big sandhills dotted with "adlib" (or "asal") bushes. These are the extreme of all adaptations to waterless life. In appearance they recall the juniper bushes of English commons but the cylindrical leaves are soft, juicy, and transparent. They will grow anywhere, even on islets in the sea where rain falls but once in five years or so, and where there is of course no flood water or underground supply. All they demand is loose sand, not less than three feet above high tide. It needs defence from starving animals and finds it not in thorns as do the acacias, but in extreme bitterness. A goat so hungry as to eat shavings and paper refuses adlib, yet that other wonderful product of the desert, the camel eats it and in summer gets little else. Our camels needed much urging to get them through the sand but we passed through on to the hard bare plain of grey gravel, where, by diligent flogging, we occasionally made them trot, a relief to our backs. My own beast was used to carrying inanimate loads, water barrels in fact, and disliked trotting; the sequel shows that my flogging and kicking had caused no unnecessary pain, if any at all

Camel Scrub.

We were now approaching some low hills of a reddish colour, their isolation and flat tops suggesting a recent sedimentary rock, a rarity in the Sudan and likely to be of great interest. As we ascended the gently rising plain we came to our first solid rock, which was gypsum, a relic of one of the Red Seas of the past which dried up, like the Dead Sea of the Jordan Valley, and left these deposits behind. The word "outcrop" will hardly do for the appearance of these rocks, for it is level with the general surface, though not a local deposit, but was once part of the hill we were approach-



YEMÉNA RAVINE, SHOWING THE GYPSUM CONGLOMERATE.

ing. My friend coined the term "flush crop," which fits the case exactly, but is hardly likely to come into common use because similar occurrences must be rare.

Caper Sauce.

Another vegetable phenomenon accompanies these "flush-crops" of gypsum, bushy caper plants, which so far as I have seen are found only upon them in the maritime plain of the Red Sea. I cannot give the proper name of this species (local name is "lessif") but it is distinct from that which beautifies the walls of Jerusalem and from the flower buds of which caper sauce is made. A profane use! The flower is of great beauty, a big delicate white flower, a marvel indeed in such a situation as this. The dryness of death all around, not another living plant in sight, no shelter, even the shade of a rock from the blazing sun from sunrise to sunset. Not only this, but in the desert which is later a furnace in which life is not possible even for its native race, the caper plant produces an edible fruit. Our caper fruit is much like a fig in size and shape, but has the colour of red sealing wax. It is but a bag of seeds with a modicum of sweet pulp,

hardly so much as in a "prickly pear," but it certainly is partially edible and to those who have seen no other fruit or vegetable for weeks or months delicious—provided it is not full of big black ants! As we neared the foothills we crossed one of those areas watered by torrents which issue from the mountain valleys after a storm. Not annually let me repeat, as is usual in the more fortunate south, but perhaps every two or three years.

The mountains forcing upwards the damp winds, cause rain, but that which falls upon them is rarely of any value, rushing directly from the rocky hills into the barren gravel of the valleys, producing no growth but the usual thorn bushes, "tooth-stick trees" and so on. That portion which issues on to the alluvial fans of the plain alone is of much use and fertilising the sand, or soil in some cases, which was deposited by former floods. The famous cotton growing district of Tokar, about 150 miles to the south, is a gigantic specimen of these alluvial fans which is flooded annually by a wild torrent from the Abyssinian highlands, flowing uselessly through stony gorges, fertilising nothing until it issues and spreads out upon the plain. Here in the north there are too many years between the floods, they are too scanty and the sand too coarse for cultivation except in the rarest instances, the tufts of woody grass described above are all that is produced. If even that were watered regularly much of the hardship of life at Dongonab would be relieved. As things are, my village has milk but one winter in three, and milk is the whole food of the natives during this part of the year. When the rain fails my workmen were forced to leave and follow their nomad relations or live on their summer diet of dura porridge, dura pancakes and dura bread (and bread baked by an old woman of Dongonab must be seen to be believed), at which body and mind revolt.

Corn in Egypt.

Dura, I should explain is *Sorghum vulgare*, a grain which grows on land just one stage removed from desert. A single flooding of an area of fine sand is enough, the dura will grow up and ripen before the hot winds come to destroy all life but the actual Xerophytic desert flora. It is to my mind one of the most wonderful of created things, and without it huge areas of Africa would be as devoid of life as the Sahara itself. We arrived at our "fertile" patch late in the season, the white forget-me-not, tiny scented stocks and yellow "dandelions" had gone, but one blue thistle-like flower remained. "Nothing to write home about." Spend a year, spend many years on the bare salt-crusted sand of Dongonab plain and a single flower

will have to you a significance which, without that experience, is incomprehensible.

The flat-topped hill being reached our camels rested while we scrambled: for all their groans they were not as thankful to be quit of us as we were of them!

We found the hill to be of sandstone and gypsum capped with coral, one of a line of similar hills (previously visited) rising from the plain and running parallel to the bases of the mountains and also to the sea.

Down to Bedrock.

On again, more camel whacking to save our aching backs, and we passed from the land which is the product of sea and wind and rain and touched the grey and ancient rocks of the mountains, the hard ribs of the world. An abrupt pyramidal hill, a few hundred feet high promised us the birds'-eye view we needed. Like many of the foothills it consists of a mass of broken rock supported by several wall-like dykes, vertical sheets of a harder rock injected when molten into broad cracks in the older and less resistant material. It is obvious that the original mass has been cut up into separate hills by storm and flood and especially by the slow but never ceasing actions of heat and cold,

damp and dryness, to which the desert climate subjects them in an extreme form. Those portions protected by these dykes have remained as hills, the intervening parts have been swept out as gravel and sand on to the plain, or as it was in the old days, into the sea. Needless to say, no gravel from the mountains ever reaches the sea nowadays, only the finest mud being carried so far by these exceptional floods which reach the sea in these latitudes. Sand is carried to the sea by the wind, sometimes in great quantities. In one part of Dongonab harbour the shore line is advancing seawards at the rate of a yard every year, but this is certainly a maximum not approached elsewhere.

The view from this hilltop was one of great interest, but the desolation was almost appalling even to us who knew the desert so well. The coastline with its familiar features, the reefs, islets and lagoons which had become so homelike were visible in every detail, yet formless, like an ill-defined shore of salt swamp.

My village was invisible, there seemed no single trace of life, or the possibility of life, in all those miles to the sea, or in the fifty miles of clear vision to the north and south. Westwards were the mountains coldly grand as aloof from all human comfort in their stony dryness as are the snow-clad alps. Yet close at hand, on the very summit of the hill, the situation of all possible the dryest and most inhospitable, grew a single "snapdragon" plant in flower!

The Rift Valley.

The geologist immediately pointed out to me the fact that looking along the summits of the foothills one finds them all at approximately one level, and described to me how he had seen the same thing among the summits of the main range to the west. This demonstrates the facts that (1) The mountains were originally a continuous mass, level-topped for considerable distances, sloping down towards the Nile,

precipitous to the Red Sea, in fact the abrupt side of the Great Rift Valley. The separate mountains into which it now carved is only the result of subsequent removal of the material which originally levelled up the valleys; (2) That the Rift Wall did not descend



YEMÈNA OASIS IN THE MARITIME PLAIN.

in one great slope but in a series of steps, the lower step having been the mass from which the foothills are the remnant. Another step, say the third, is the foundation of the old coral reefs rising from the plain, the fourth the present shore line and fringing reefs, the fifth the barrier reefs out at sea.*

Since the latest features of the rifting process are geologically speaking events of yesterday and the earliest took place "before ever the mountains were brought forth"—or rather, carved out—these earth movements have occupied a considerable time, even by the geologist's scale, ages almost incomprehensible by that of human history. A detailed study of the gravels of the plain, which sometimes underlie coral sandstone and gypsum, and are therefore of all ages since the first uplift of the plateaux and its fracture, might throw much light upon this extraordinary drama. It is well known

* See the author's papers in *Journal Linnean Soc.*, vol. xxxi., or his "Desert and Sea Gardens," Camb. Univ. Press.

that, vast as the heaving and splitting were to produce the Red Sea (and its predecessors in this great valley) this is but a part of the fracture, for the Rift Valley



THE DONGONAB PLAIN,

begins in Lebanon, passes through the Jordan Valley to the Red Sea and down through Africa to far south of the Equator.

Unloved Camels.

A camel may have had a rest while his rider has been climbing, but none the less does he groan and curse as you remount him, and mine at least needed plenty of stick to get him out of his back-breaking walk. However, when we passed my friend's camp my beast began to go better, scenting home I supposed,

so I gave him a loose rein, and let him go. Faster and faster he went—tired? Not a trace of it! He soon went faster than I liked and was hammering me violently on the saddle. Hauling on the single rein had less effect in checking him than the stick had in quickening his pace earlier in the day, and thorn bushes and sky began to intermingle strangely in my vision. There was no keeping him in the direction of my house, he wanted his companion at my friend's house and meant to get there? Soon I was reduced to ignominiously hanging on to the pommel of the saddle, and wondering how soon the beast would scrape me off against a thorn tree. As we approached the tents I yelled and a man ran out and caught him, otherwise my friend and his bath would have been buried under his collapsed tent! "Hallo Crossland" said he with his usual imperturbability, you're all over blood." I was horrified, fearing the loss of the next day's excursion, but found it was only from my hand, where it had rubbed against the angle of the wooden pommel. So leading him well away from the camp I mounted once more, but honour being once satisfied I found I was too sore for further travel of this kind and walked in. A man may value his camel above all earthly possessions, and a native usually does, but love him? Never!

The Will to Power.

(The Practice and Theory of Individual Psychology.)

By Alfred Adler (Vienna).

DR. ADLER is the leader of one of the more important schisms or developments from the original Freudian School of psychology, and though he differs from it more by what he rejects than by the addition of any strikingly new principle, yet he makes a valuable contribution to psychology by throwing into relief certain factors whose practical importance is perhaps liable to be underestimated. His thesis is extremely simple and comprehensive: "Mental phenomena when correctly understood may be regarded as leading up to an end which consists in establishing the subject's superiority." This striving for personal prestige and superiority inevitably clashes with the demands of society, which claims a certain sacrifice of individual interests; it clashes also with the impulse to love another individual as well as, or better than, ourselves. The conflict that results was pictured by Freud as the difficulty encountered by the individual in transferring interest, energy and affection from the self (where

they are centred during childhood) to objects, and people. A gross failure to make this adaptation to society produces that easily recognised type of individual who "is his own lover and has not a rival in the world," the "Narcissist" of Freudian psychology.

Dr. Adler claims that in all neurotics and probably in 90 per cent. of the human race, the universal striving for superiority is complicated by a feeling of inferiority that leads to a vast series of elaborate devices and a great deal of preoccupation in order to conceal the real or imagined inferiority from others, or to satisfy the *amour propre* by providing adequate excuses for failure.

Inferiority Complex.

In a previous book Dr. Adler was inclined to stress bodily imperfection as the source of the feeling of inferiority, but he now seems to give greater weight to that feeling of inferiority that all children experience in some degree when they compare themselves with

their parents, and that little girls are apt to feel in comparison with their brothers. Both these factors have been dealt with very elaborately by Professor Freud and his followers.

The devious results of an unconscious feeling of inferiority are of some general interest, for they are tolerably easy to recognise and they give a clue to the understanding of many anomalies of behaviour that would otherwise be rather puzzling. A simple example, though Dr. Adler does not use it in the present book, is the phenomenon of shyness. This becomes fairly comprehensible when we find that it appears, typically, in the presence of a stranger, who is bound to be forming an opinion of the individual hitherto unknown to him. The victim of shyness at once becomes "self-conscious," that is, he turns his attention on to his own behaviour, consciously directing it lest he should "give himself away" and so expose his inferiority. This process of safeguarding the real self from criticism may be carried still further and a camouflage of loquacity, stony reserve, or even hectoring self-assertion, may be thrown out.

But the real trouble of the shy individual is not his inferiority, which may be imaginary, but the importance that he attaches to it, and the turn of mind that prevents him from recognising it and dealing with it openly. It is this failure to understand his own motives that makes the condition seem so unreasonable and irksome to the sufferer, but it also opens up the possibility of dealing with the trouble successfully.

Disease of Civilisation.

This conflict between the feeling of inferiority and the desire for prestige may be detected in many other traits that are not definitely "morbid," but it is difficult to follow Dr. Adler in his belief that the will to power is the dominant, almost the exclusive motive of human conduct. It is admittedly of little or no biological service, for the goal (he calls it the "fictive goal") is not the perfection by the man of his abilities, nor is it self-protection, but simply the recognition by his fellows of his superiority over them. It may be that it is, in some sort, a disease of civilisation, a disability that comes from a greater awareness of the self, that might follow from the intensification and widening of our consciousness that seems to proceed with the march of civilisation.

It is unfortunate that in this present book Dr. Adler supports and illustrates his thesis principally with data from morbid psychology, for it is especially in this sphere that its narrowness is most apparent. Those who are familiar with neurotic cases will probably admit that the "will to power" conflict is

paramount in a certain number and present to some extent in many more, but that there is no other source of conflict worth considering, is a simplification that to the majority is likely to seem more desirable than possible.

Dr. Adler lays great stress on the use that the neurotic makes of his symptoms, specially the exploitation of them in order to attract the interest or exact the service of his friends and family. This again is of some general interest, for it is a motive that is very often guessed at by the friends, whose attitude towards the patient is consequently coloured by a vague suspicion that he is malingering. This adds to the misery and bitterness of the patient, who is, almost invariably, quite unconscious that he is ever using his symptoms to his own advantage, and he is driven to further complexities in order to demonstrate the "reality" of his sufferings.

Morbid Types.

In addition to the data derived from his practice, Dr. Adler gives an analysis of two morbid personalities, one the hero of a novel—"Hofrat Eysenhardt," the other a novelist—Dostoyevski. These analyses of unreal or remote characters, that offer such an easy field for the speculations of the analyst, are apt to make tedious reading, but the chapter on Dostoyevski reveals a deep sympathy with the subject, and, as far as any man can be sure, an appreciative understanding. But, what perhaps is more important, it reveals that Dr. Adler appreciates the existence of a real striving towards a goal other than that "fictive goal" which he seems to make the object of every man's desire. In Dostoyevski he sees the real goal as a synthesis "uniting the heroic life with love of neighbour," so that the apparent cynicism and the belittlement of human motives that runs through Dr. Adler's work may perhaps be attributed rather to his vehemence in unmasking the ideal of superiority, than to a failure (as it is apt to seem) to recognise the existence of any other.

The book includes a short section on education, demoralised children and the psychology of prostitution; and as it is made up of a series of lectures delivered to different audiences there is inevitably a certain amount of overlapping of the contents and some lack of coherence in the general arrangement.

It is unfortunate that more care has not been given to the translation, which is clumsy and sometimes ungrammatical, while such words as "methodology" (the context demands "methods") "autism" and "spasmophilic" are very near to jargon.

F. A. HAMPTON.

The Differentiator.

By Julian Huxley.

Experimental work in biology is producing astonishing results and vast new fields of research are being opened up. In this article the author indicates how the graft of certain cells from the embryo of one animal into the embryo of a totally distinct species produces definite progress in the latter. It is a first step, an achievement and a discovery of the greatest importance.

"THE Differentiator": it sounds as if here we had a new career—something rather technical and out-of-the-way, at which, if one had the gift, one could make a good living. It is, however, nothing so practical or merely human. Differentiators are a new biological discovery, which we owe to Professor Spemann of Freiburg; and a very important discovery too.

To differentiate, in all higher animals and plants, is to develop; the two are almost synonymous. All of us living things, whether you or I or a bean-plant, whether a frog or a cuttle-fish, start our cycle of existence in much simpler form than that in which we end it.

A more or less spherical mass of living substance, with a central nucleus, and perhaps a greater provision of yolk at one end than the other—that is in general the sum total of complexity at the start of life. Then the mass, which we call the fertilized egg, divides and subdivides into a great number of cells; and the cells, in all the higher animals, rearrange themselves into three chief or primary layers. All the while, however, no rudiment of any of the main organs of the body has appeared.

Groundwork of Organs

That follows. Along the future back, in a vertebrate such as a frog, or bird, or man, there appears a thickening—the future nervous system. This grows up at the sides and becomes converted into a hollow tube, with a swelling at the front end foreshadowing the brain. Below it appears the primitive skeleton, a simple rod of elastic tissue, and on either side the kidneys, with the future heart as a little tube below. These various organs grow, become complex, and develop an intimate structure which enables them to work; the cells of the nervous system send out their thread-like processes which connect with sense organs and muscles, those of the muscles elongate and become fibrillar and capable of contraction, the cells of glands begin their chemical manufactory. Other organs are laid down in their rudiments and go through similar changes; and in a few days, or at most weeks, the whole complex organization of the animal comes into being, first blocked out in space, then internally

changed to become functionable, until the whole is transformed into a working mechanism, capable of independent and active life. After this, the changes are less marked; they consist chiefly in growth and in relatively slight changes in proportions.

The first moment of fundamental change comes when the germ is launched on its career as an independent biological unit—at fertilization. The second is clearly that when differentiation begins, with the first trace of the real organ-systems of the creature; and the third comes when function is first possible, and the animal begins to work in its characteristic and definitive way.

It is the second with which we are here concerned—the marvellous generation of something out of nothing which we disguise under the term differentiation. One of the great biological achievements of last century was the unravelling, so far as mere observation and description could carry, of all the details of the process in a vast range of animal species. The process, as a series of events, has become well known. But the *how* of it had hardly been touched—indeed, so little light had we on that side of the problem, that many workers felt that *how* was not worth asking.

How it is done.

And now comes in Spemann. He has been working on the development of the newt for over twenty years (it is a golden rule in biology to look for favourable material, and, once found, to keep on with it). After the fertilized egg has cut itself up into small cells, the next step is for the upper cells to grow down and cover the lower. There is then a circular zone of down-growth, marked by a visible rim or lip; but the down-growth starts at one point of the circle—on what will be the dorsal side of the embryo—and spreads round gradually to complete the circle; this first active region is called the *dorsal lip*.

By a series of observations and experiments, Spemann was able to conclude that there was some causal relation between the dorsal lip and the start of differentiation. Finally, by ingenious technique, he was able to put his hypothesis to experimental test. He freed the developing egg from its protective mem-

branes, and then with a special pipette and a fine needle-knife removed a small portion of the dorsal lip region and grafted it into some abnormal situation in another germ. The result was as he expected—the host-germ developed not only its own set of embryonic organs, but a second set in relation to the graft.

The natural conclusion to draw was that the graft, by virtue of some rapid inherent power of growth, had itself formed the "secondary embryo." This again he put to the test by grafting the dorsal lip from one species into another, the one species being heavily pigmented, the other almost colourless, so that the tissues derived from the graft could be distinguished, even in late stages of development, from those belonging to the host. The first point of interest was to find that the grafted dorsal lip exerted just the same effect, and as powerfully, in another species as in its own. But the greatest surprise was to follow: it was discovered that almost the whole of the secondary embryo was composed of the tissues of the host.

The grafted dorsal lip had *induced* the central organs of an embryo in tissues which, left to themselves, would have formed nothing but such indeterminate structures as their own blood-vessels. Some influence had spread from it which made the tissues of the host build themselves up in the special and orderly way of differentiation. It was a *differentiator*. In later experiments he has been able to induce development in a newt by

means of grafting the differentiator from a toad—animals as different as horse from armadillo, or monkey from pig. A vast field of research is thus opened up.

A Wonderful Prospect.

As usual, the first question solved raised more numerous problems for solution. Differentiation is induced by the dorsal lip; yes, but what sort of influence is it which causes this induction? Here we at present can only fall back on one fact, but a suggestive one—to wit, that at the moment of its power, the dorsal lip is the most active region of the germ, the region where cell-division is most rapid. Here we have an analogy—distant, no doubt, and rough, but none the less interesting—with human affairs. What more familiar than the fact that in the nations a few exceptionally active minds, whether in art or science, politics or business, determine the way in which other less active minds shall employ themselves, shall build their lives—the way in which the community's differentiation shall proceed?

And there for the present we must leave the problem. We can have the assurance that a first step of the greatest importance has been taken—a first step comparable in its own field with Mendel's first step—the idea of segregation of unit-factors—in genetics, or Dalton's first step in chemistry. It is a first step towards the understanding of differentiation, with its eventual corollary, the control of development.

The Sovereignty of Polar Lands.

By R. N. Rudmose Brown, D.Sc.

Science and commercial development are working together to develop the latent utilities of Polar lands. In the future these may be extremely important for their mineral wealth and possibly in connection with food reserves. During the last few years several thousands of miles of territory have been added to the Empire by the annexation of unclaimed lands.

AMONG the many changes that in recent years have appeared in the political map of the world, those which have drawn least attention are the disappearances of the unclaimed lands around the Poles. The poleward march of sovereignty has made steady progress during the twentieth century but has evoked little interest among the public. Probably very few British subjects realize that within the last few years the British Empire has grown in size to the extent of several thousand square miles, not by conquest or by treaty, but simply by undisputed annexation of unclaimed lands. In most cases of polar territorial claims lands without permanent population have been annexed and in some cases lands with no inhabitants at any season of the

year. This increase of territory has generally been the outcome of commercial exploitation of the annexed lands, often but not invariably by the subjects of the interested state, and it marks the growing realization that polar regions are not the useless wastes that three centuries of arduous exploration falsely impressed on the popular mind. Only where a polar land or sea is covered by permanent ice can it be said with certainty to have no economic value.

Polar Land is Valuable.

From the earliest days of polar exploration territorial claims from time to time have been made, but as often as not without authority and there are

few instances of such annexations being confirmed. In any case, annexation by private persons is null and void. To be valid it must be an Act of State. Unless performed by officers commissioned for the purpose it must be ratified by the state concerned, or it has no significance.

The criteria of ownership of uninhabited lands are not settled and by the nature of the problem are difficult to decide. No law can be cited and precedent is too contradictory to be a useful guide. Many instances could be given to show that discovery and exploration do not in themselves constitute a title to ownership. It has been argued that by international usage annexation without settlement lapses in five years' time, or at any rate that settlement if not continuous must be intermittent, and that entire abandonment for a considerable time nullifies ownership. But even if a rule of this kind were accepted its liberal application would lead to many disputes. For instance, what area must be considered a unity? Does settlement of one island constitute a valid claim to a whole archipelago, even if the islands are widely scattered? Does the utilization of one spot on a coast entail the sovereign right to a great island or stretch of mainland? If there was more competition for the sovereignty of polar lands these problems would require to be solved. In practice they have little but academic interest.

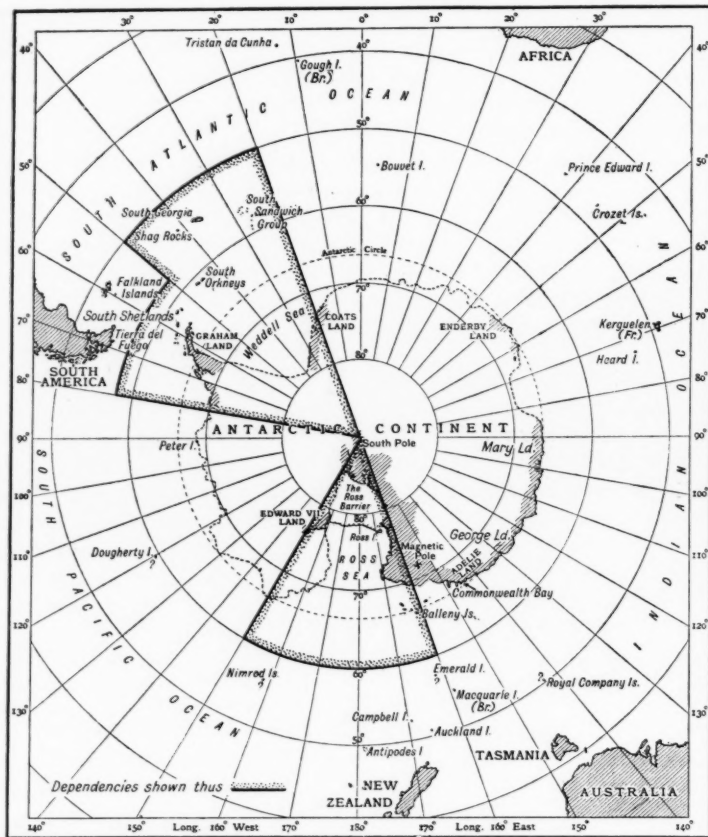
Since annexation of polar lands has a purely economic basis, although strategic value has been hinted at in

one or two cases, it follows that sovereignty is mainly due to the expansion of adjacent states. It marks a growth of interests polewards by reason of economic infiltration. In consequence there are only five powers whose writ runs in polar lands; in the Arctic, Canada, Russia, Denmark and Norway, and in the Antarctic, Britain, by the extension of Falkland Island and New Zealand authority. The United States by the possession of Alaska has Arctic territory, but that

was a matter of purchase from Russia. A more interesting anomaly is the French possession of Kerguelen in the Southern Ocean. It was a French discovery and annexation in 1772 and has been intermittently occupied, but not solely by French subjects. In 1893 it was formally annexed and attached to Réunion.

Early Settlers.

The earliest European occupation of Arctic regions was the Viking settlement of south-west Greenland. A survival of this is the long established Danish sovereignty on the coastal regions of the west and south-east, including Angmagsalik in lat. $65^{\circ} 30' N$. But in the far north and the now uninhabited northern part of the east coast, there never was a Danish trading station. Danish jurisdiction on the west coast used to be limited on the north by the parallel of lat. $74^{\circ} 30' N$. American discoveries in the north preceded the excellent work of exploration by Danes, but on the transfer of the Danish West Indies (Virgin Islands) to America in 1917, the United States withdrew any claims to parts of Greenland, leaving Denmark with

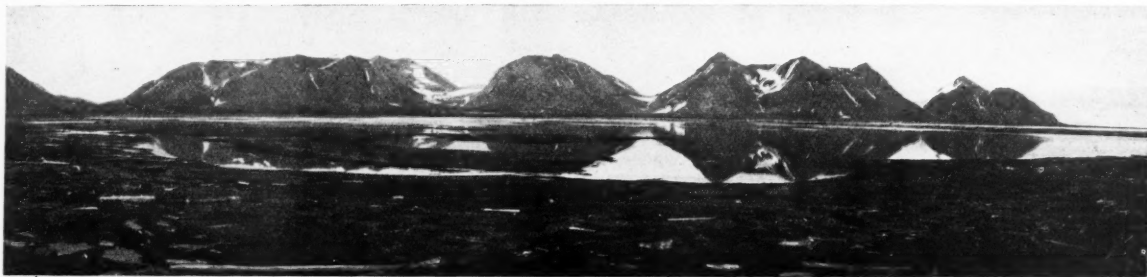


MAP OF ANTARCTIC CONTINENT SHOWING BRITISH DEPENDENCIES.

sole sovereignty over the whole island. This aroused some dissent in Norway, since only Norwegian hunters visit the north-east coast, and on their behalf Norway rightly claimed that no impediment should be offered by Denmark. Norway, moreover, recently erected a wireless meteorological station on the east coast of Greenland in lat. $73^{\circ} 30' N$. Feeling ran high in both countries, although Norway disavowed any territorial claims in Greenland. And it was not forgotten that Greenland for many centuries was a Norwegian colony and that Norway lost all rights only on the separation of Norway from Denmark in 1814. The dispute, however, is now virtually settled.

The sovereignty of Norway has now extended overseas. The island of Jan Mayen in the Greenland Sea does not appear to have been annexed formally, but it has been permanently occupied since 1920 by a

Australia, South Africa, New Zealand and India; the United States; Denmark; France; Italy; Japan; Norway; Holland; and Sweden. One of the articles expressly states that until the recognition by the contracting parties of a Russian Government permits Russia to adhere to the Treaty, Russian nationals shall enjoy the same rights as nationals of other states and their claims to mining territory shall be presented through the Danish Government which has consented to act as an intermediary. The Soviet Government would appear to be dissatisfied with the Treaty. Last year it was reported to have protested against Norwegian sovereignty of Spitsbergen, maintaining that the islands could be controlled only by an international commission of all states interested in their commercial development. This statement is reminiscent of the notorious Brest-Litovsk Treaty



PRINCE CHARLES FORELAND, SPITSBERGEN.

wireless station of the Norwegian Meteorological Institute. It is also visited occasionally by Norwegian hunters. And Norway could make out a reasonably strong case if not for Norwegian discovery at least for Viking discovery from Iceland. The acquisition of Spitsbergen is a more important extension of Norwegian sovereignty in view of the vast resources of high-grade coal which the islands contain. The history of rival claims to this No-Man's land is too long to enter into here. But in spite of annexations by more than one state and occupation by the nationals of several, it was regarded as a *terra nullius* at the conference which met in 1914 to decide on some form of government. The war put an end to that discussion and the Spitsbergen problem was not solved until the Supreme Council in 1919 handed it to Norway under certain conditions. The Treaty at the time of writing is not yet operative as certain formalities await completion. Bear Island, between Norway and Spitsbergen, where also coal is being mined, is included with Spitsbergen in the Treaty. The Spitsbergen Treaty was signed by Britain, including Canada,

of 1918 in which Germany and the Soviet agreed to request the Norwegian Government to resume the interrupted Spitsbergen conference as soon as possible. This conference had aimed at some form of international government. Meanwhile the exploitation of Spitsbergen coal continues and the mining settlements, British, Norwegian, Swedish and Dutch grow year by year. Last year the total export of Spitsbergen reached some 350,000 tons of coal.*

Russian Islands.

The island groups north of Russia and Siberia, with two exceptions, ever since their discovery have been regarded as Russian. Some are inhabited, others are visited by Russian or Siberian native traders and hunters, but the argument of propinquity, in most cases, should be enough to establish the Russian claims. In 1916 the Russian Government formally notified other states that these lands were part of the Russian Empire. The islands named in this memoran-

* For the political history of Spitsbergen see R. N. Rudmose Brown's *Spitsbergen*, London, 1920, and "Recent Developments in Spitsbergen," *Scottish Geographical Magazine*, April, 1920.

dum were the newly discovered Nicolas II Land, and Alexis and Starkadomski Islands as well as the islands known as Henrietta, Jeannette, Bennett, Herald, Ujedinenia, New Siberia, and others "situated near the Asiatic coast of the Empire." No reference was made to Franz Josef Land although on August 18, 1914, Captain Isliamov of the Russian ship *Gherla* raised his country's flag and laid claim to the archipelago. Except on the score of propinquity Russia would be hard put to substantiate a claim to that group, if she were so inclined, since it was discovered by Austrians, explored mainly by British and Americans, and is seldom visited except by Norwegian hunters. Franz Josef Land may be regarded as the last of the Arctic No-Man's lands.

Dominion Extensions.

By the extension of sovereignty over unclaimed, but not uninhabited lands Canada's rule covers the Arctic archipelago north of America. As long ago as 1875 the North-West Territories Act laid claim to many of these islands, and sovereignty has since been confirmed and extended by the official hoisting of the flag in many islands as far north as Ellesmere and Grinnell Lands and, with more certainty, by the establishment of Canadian Mounted Police posts in Cumberland Sound, Pond's Inlet, Ellesmere Land, and elsewhere. Canada has made good her claim to all lands west of Greenland between the northern shores of the Dominion mainland and the North Pole. A great part of this Arctic region was revealed by British explorers, but some was discovered and mapped by Norwegians and Americans. Canada's claim is not disputed, unless we accept seriously the amazing announcement which appeared in the Press last January that the precise object of the proposed flight of the United States airship *Shenandoah* this summer was the annexation of new Arctic lands and the North Pole. Even if new islands are discovered in the Arctic Ocean, which is not very probable, the North Pole itself is in the sea! Annexation from the air promises to add a new problem to the many complexities of territorial rights in polar islands.* The Canadian Government vessel *Arctic* is reported to be sailing this summer for Arctic waters to take formal possession of other islands in the Canadian Arctic Archipelago with a view to forestalling any possible American action.

South Polar Regions.

In the Antarctic regions Britain alone has made any serious claim to territory. On more than one

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occasion the British flag has been hoisted. In this manner W. Smith took possession of the South Shetlands in 1819, G. Powell the South Orkneys in 1821, J. Biscoe claimed Graham Land in 1832, and Sir J. C. Ross Victoria Land in 1841. In the last case the claim was made without an actual landing on the mainland. At a later date Prof. Edgeworth David, acting on the instructions of Sir. E. H. Shackleton (1908), claimed for the British Empire the area of Antarctica containing the South Magnetic Pole, and in 1912 Mr. F. Wild took possession of Queen Mary Land "for King George V and the Australian Commonwealth." Another form of annexation was that of Mr. C. E. Borchgrevink when in 1899 he took possession of Duke of York Island, South Victoria Land, "for



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Sir Geo. Newnes, under the protection of the Union Jack." But it is a little doubtful if any of these annexations had validity. At any rate, in the absence of inhabitants the King's rule never operated in these regions and no notification of claims would appear to have been communicated to other states. The Argentine Republic used to maintain a vague claim to the South Shetlands, and since 1904 the Argentines, by virtue of their meteorological station, have been in sole permanent occupation of the South Orkneys. The South Orkneys for many years were at least regarded as a separate postal district of the Argentine territory of Tierra del Fuego.

Control of Whalers.

It was the operations of whalers which led to the extension of British rule to certain Antarctic lands. In 1908 by Letters Patent the Governor of the Falkland Islands was appointed Governor of the Dependencies of South Georgia (annexed by Captain J. Cook in 1775),

the South Shetlands, the South Orkneys, the South Sandwich Group and Graham Land. The area of the territories was defined by the parallel of 50° S, and the meridians of 20° W and 80° W. This area, however, included part of South America. Letters Patent of 1917 modified and extended those of 1908. The Dependencies of the Falkland Islands now include "all islands and territories whatever" between long. 20° and 50° W., south of lat. 50° S., and between long. 50° and 80° W., south of lat. 58° S. Several of these islands provide valuable whaling stations and thus afford, by a small license fee and tax on the oil, a considerable source of revenue. In 1922 the export trade of the Dependencies was valued at some £2,500,000, and the revenue was £142,000 compared with an expenditure of only £13,000. This may be compared with the export trade of the Falklands themselves which was £103,600, while their revenue was £44,700. The surplus revenue of the Dependencies is devoted entirely to scientific research and development work in the islands and adjacent waters.

On the other side of Antarctica is the newer Ross Dependency of New Zealand. This comprises the

islands and territories between long. 160° E. and long. 150° W., which lie south of lat. 60° S. The greater part of South Victoria Land and Edward Land are included but King George Land and the Magnetic Pole area are excluded. This Dependency was constituted by an Order-in-Council in July 1923, and it would appear from the wording that the region named was considered to be already within the British Empire, consequent no doubt on Ross's annexation of 1841. The establishment of British authority in the Ross Sea area is due to the extension of whaling. During the southern summer of 1923-24 the well-known Norwegian whaler, Captain C. A. Larsen, with a large floating factory and six whale catchers secured over 200 blue whales and 17,000 barrels of oil in spite of somewhat difficult ice conditions.*

It will be noted that both these Antarctic Dependencies bring British sovereignty nominally to the South Pole. Other parts of the Antarctic continent are No-Man's Land.

* An article on the history of these Antarctic Dependencies appeared in the *Geographical Journal* for November, 1923.

Marriage and Medical Examination.

A frank article on a vital subject. Public opinion would not support parents who permitted a daughter to marry a drunkard, yet false modesty prevents many people insisting on a clean bill of health as an essential preliminary to marriage. When the family solicitors are discussing settlements the family doctors should be called on to send in their certificates as well. Both professions are there to help and safeguard the future generation.

THERE are certain definite occasions upon which every man is willing, and indeed is forced, to face a medical examination. Before he insures his life, before he joins a public service, and before he goes abroad with a commercial firm he must produce a clean bill of health. He does not think this unreasonable, nor does he find it offensive in practise. On the contrary, the insurance policy examination, for example, is a real branch of preventative medium.

In striking contrast to such cases is the light-heartedness with which men and women face marriage. The insurance company, the state, the commercial firm demand assurance of health in their own interests. But a man is ready to sacrifice a life-times happiness by neglecting to make certain of his fitness for marriage.

It is time that a new convention should arise with regard to marriage. Prospective husbands, wives, and, lastly but most urgently, fathers-in-law, must learn to expect as the natural right an assurance as

to certain well-defined facts. No fiancé tries to conceal the state of his bank account from his father-in-law to be, though in ordinary circumstances inquiries about it might be considered an impertinence. But certain health questions are of infinitely greater importance.

Straight Facts

At the outset it is necessary to remove a very general prejudice. Eugenics, it must be admitted, is a distasteful word to many. Rightly or wrongly it implies that only those shall be permitted to marry who pass some arbitrary standard of intelligence, stature and social value, quite apart from health, and that the Romeos and Juliets of to-day are not to woo and wed, inspired by love-glances from a balcony, but according to some gigantic state stud-book. The question at issue is much more simple. Medicine has now reached a stage at which certain infectious diseases can be diagnosed with absolute precision. Many sufferers

dum were the newly discovered Nicolas II Land, and Alexis and Starkadomski Islands as well as the islands known as Henrietta, Jeannette, Bennett, Herald, Ujedinenia, New Siberia, and others "situated near the Asiatic coast of the Empire." No reference was made to Franz Josef Land although on August 18, 1914, Captain Isliamov of the Russian ship *Gherta* raised his country's flag and laid claim to the archipelago. Except on the score of propinquity Russia would be hard put to substantiate a claim to that group, if she were so inclined, since it was discovered by Austrians, explored mainly by British and Americans, and is seldom visited except by Norwegian hunters. Franz Josef Land may be regarded as the last of the Arctic No-Man's lands.

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the South Shetlands, the South Orkneys, the South Sandwich Group and Graham Land. The area of the territories was defined by the parallel of 50° S, and the meridians of 20° W and 80° W. This area, however, included part of South America. Letters Patent of 1917 modified and extended those of 1908. The Dependencies of the Falkland Islands now include "all islands and territories whatever" between long. 20° and 50° W., south of lat. 50° S., and between long. 50° and 80° W., south of lat. 58° S. Several of these islands provide valuable whaling stations and thus afford, by a small license fee and tax on the oil, a considerable source of revenue. In 1922 the export trade of the Dependencies was valued at some £2,500,000, and the revenue was £142,000 compared with an expenditure of only £13,000. This may be compared with the export trade of the Falklands themselves which was £103,600, while their revenue was £44,700. The surplus revenue of the Dependencies is devoted entirely to scientific research and development work in the islands and adjacent waters.

On the other side of Antarctica is the newer Ross Dependency of New Zealand. This comprises the

islands and territories between long. 160° E. and long. 150° W., which lie south of lat. 60° S. The greater part of South Victoria Land and Edward Land are included but King George Land and the Magnetic Pole area are excluded. This Dependency was constituted by an Order-in-Council in July 1923, and it would appear from the wording that the region named was considered to be already within the British Empire, consequent no doubt on Ross's annexation of 1841. The establishment of British authority in the Ross Sea area is due to the extension of whaling. During the southern summer of 1923-24 the well-known Norwegian whaler, Captain C. A. Larsen, with a large floating factory and six whale catchers secured over 200 blue whales and 17,000 barrels of oil in spite of somewhat difficult ice conditions.*

It will be noted that both these Antarctic Dependencies bring British sovereignty nominally to the South Pole. Other parts of the Antarctic continent are No-Man's Land.

* An article on the history of these Antarctic Dependencies appeared in the *Geographical Journal* for November, 1923.

Marriage and Medical Examination.

A frank article on a vital subject. Public opinion would not support parents who permitted a daughter to marry a drunkard, yet false modesty prevents many people insisting on a clean bill of health as an essential preliminary to marriage. When the family solicitors are discussing settlements the family doctors should be called on to send in their certificates as well. Both professions are there to help and safeguard the future generation.

THERE are certain definite occasions upon which every man is willing, and indeed is forced, to face a medical examination. Before he insures his life, before he joins a public service, and before he goes abroad with a commercial firm he must produce a clean bill of health. He does not think this unreasonable, nor does he find it offensive in practise. On the contrary, the insurance policy examination, for example, is a real branch of preventative medium.

In striking contrast to such cases is the light-heartedness with which men and women face marriage. The insurance company, the state, the commercial firm demand assurance of health in their own interests. But a man is ready to sacrifice a life-times happiness by neglecting to make certain of his fitness for marriage.

It is time that a new convention should arise with regard to marriage. Prospective husbands, wives, and, lastly but most urgently, fathers-in-law, must learn to expect as the natural right an assurance as

to certain well-defined facts. No fiancé tries to conceal the state of his bank account from his father-in-law to be, though in ordinary circumstances inquiries about it might be considered an impertinence. But certain health questions are of infinitely greater importance.

Straight Facts

At the outset it is necessary to remove a very general prejudice. Eugenics, it must be admitted, is a distasteful word to many. Rightly or wrongly it implies that only those shall be permitted to marry who pass some arbitrary standard of intelligence, stature and social value, quite apart from health, and that the Romeos and Juliets of to-day are not to woo and wed, inspired by love-glances from a balcony, but according to some gigantic state stud-book. The question at issue is much more simple. Medicine has now reached a stage at which certain infectious diseases can be diagnosed with absolute precision. Many sufferers

from these diseases do not realise the fact that they are infected. Public opinion must be educated so that the marriage of such individuals becomes an impossibility; the diseases are curable, and the patients must await a cure before marriage.

A father-in-law must demand, in his daughter's interest, an assurance on two points at the very least. Has the prospective husband tuberculosis in an infectious stage? Has he any form of venereal disease?

Both these questions can be answered either in the affirmative or the negative with as high a degree of certainty as any merely human problem. The bacillus of tuberculosis is most distinctive; if present in the sputum of a patient that patient should not marry. If he does, he may infect his wife. There is on record the case of a patient whose three wives died of consumption before he finally died of the same complaint, which he had suffered from in a chronic state since before his first marriage. Again, a blood test will definitely exclude syphilis, and bacteriological tests exclude other forms of venereal disease. There may be disagreement as to whether a man has typhoid, small-pox, or measles; but a positive blood-test means syphilis and nothing else.

Every doctor, every medical student, and a great many laymen can speak of cases where a marriage, entered into with every prospect of happiness, has led to bitter failure and misery through infection with venereal disease. Thanks to a broad-minded attitude towards these questions, which has only lately sprung up, most people know now that blindness is very often caused by venereal disease, that children are infected from birth, and become stone deaf in child-hood, that wives become acutely ill with severe symptoms needing operation, through venereal disease, and that statistics show that 5 per cent. of the population of England have syphilis. The figure for other forms of venereal disease are far higher. It is no good not facing the matter; it has been said that few men reach thirty unmarried without suffering from some form of venereal disease.

A Parent's Duty

In England both tuberculosis and venereal disease can be investigated free of charge at State Clinics. The most impecunious individual can therefore afford to have his own case looked into.

Undoubtedly an honourable man will seek to determine his state of health before marriage if he has doubts upon it. But that is not enough. He may well be affected without his knowledge. That is why, at present, it is the duty of a father-in-law to ask these questions himself, and not to be satisfied save with a medical certificate. It is not suggested that an

unsatisfactory report should finally prevent marriage. These diseases are curable; the cure must be awaited.

About tuberculosis and venereal disease there can be no question. A man who marries with those diseases in an infectious form, knowing himself to be infected, is far worse than many a criminal. But there are other questions which may arise. Insanity is one such, and here the issue is far less simple. If insanity in a family excluded marriage, few indeed would marry. But at least a girl should know that her fiancé's parents, for example, have both died in asylums. She may still abide by her choice; Charles Lamb was the son of a lunatic and the brother of a lunatic.

Again, an examination may disclose chronic heart disease. A life of invalidism is a possibility; at the very least a less hopeful outlook in a competitive world. One might say that a marriage avoided from such consideration would be shamefully avoided. But the consideration is at least as relevant as the question of the bank balance.

Equal Responsibilities

It may be remarked that nothing has been said of the woman's part in the marriage. As our social organisation is at present determined, this is inevitable. The man is the wage-earner, his health is the most important. In actual practice, also, venereal disease in married life is an infection from the husband in nine cases out of ten. A young girl, moreover, needs the assistance of a father, and his experience in facing marriage; a man presumably proposes marriage with his eyes open.

In her own interests, however, she should determine certain facts. More than half the deaths in child-birth might be prevented by examination before marriage. Some women could never have a child save by surgical operation. They should know these facts before marriage; later on is too late.

There are, it is true, several conditions which are hereditary, and are only handed on by women. The Royal House of Russia, for example, is said to have been afflicted with a condition known as Haemophilia, in which the blood does not clot, and a slight cut means death. This condition is handed down only by women. But it is too rare to be considered in this connection.

The issue is, therefore, quite plain. Perhaps in time there will be a law making marriage—when knowingly or un-knowingly suffering from infectious tuberculosis or venereal disease—a crime. Till then, a father who neglects to satisfy himself on these two points has involved himself in a responsibility which he may regret for the rest of his life.

M.B.

"Death Rays" and "Heat Rays"

By H. P.

Astonishing claims have lately been made concerning the projection of "Mystery Rays" over distances. The newspaper claims made have not, so far as we know, been scientifically verified, or to the time of writing demonstrated before any expert committee or important scientific society. Until such verification is obtained no serious discussion of the matter is possible but the following article may be found suggestive of possibilities.

THE "Death Ray" evolved by Mr. Grindell Matthews and christened by the daily press has been one of the pseudo-scientific marvels of the last month. This inventor received £25,000 from the Government for his system of controlling boats, fitted with a "selenium pilot," by a searchlight beam. A model boat incorporating this device was demonstrated during the war.

It is a moot point how far the use of invisible rays has progressed because it is only occasionally that a lay inventor seeks publicity for new discoveries whose utility is mainly military. Wireless direction for boats and torpedoes was experimentally employed by both groups of combatants in the late war. Little was said about it and in navy parlance it is a subject which is still slightly "pink," a cryptic term indicating that even if we do happen to know something, we are not prepared to make a song about it.

Foreigners are very interested in this kind of discovery, and a number of foreign correspondents of various papers in England invited Mr. Grindell-Matthews to a lunch and showed a most generous appreciation of his work. It is to be hoped that our own authorities will be no less backward in seeking the assistance of a new discovery, which will do much to make war either impossible or intolerable. The only excuse any state department can make for not acquiring such a secret for much fine gold and guarding it against all alien inquirers is that they know all about it or have something rather better in stock. Recent press notices indicate that Mr. Matthews is finding a happier home for his secret with a French firm; and a number of other inventors also claim to be able to produce similar effects.

War Secrets.

The full tale of the war contribution of experimental physicists and inventors is never likely to be told. There were curious experiments with invisible heat rays. Masked "dark" searchlights were focussed on raiding planes and peculiar bombs or air mines climbed along the invisible ladder of heat rays. Lots of things were mooted, some were tried, a few were successfully employed, then just as a lot of interesting

novelties were about to appear the war—thank goodness—stopped.

Now about mystery rays. There have been quite a lot of them about since the war. The French complained with notable asperity that the Germans were using some objectionable form of frightfulness that burnt out the magnetos of French planes flying across German zones outside occupied territory. Almost simultaneously an Italian press message chronicled a few odd experiments at Toulon and mentioned the classic name of Ulmo, an ex-naval officer who combined a gift for the application of invisible rays with a regrettable taste for opium smoking and selling secrets to foreign powers.

Radio Energy.

Drawing a general inference one may conclude that independent workers of various countries have reached a point where a directional ray or wave can be used for the wireless transmission of energy in the form of heat. How this conversion of high frequency energies is focussed at a distance presents interesting problems, but if one considers Senator Marconi's experiments with directional wireless, how a parabolic "mirror" of short aerials focusses a "beam" of radio energy on a receiving station, or one considers the peculiar properties of certain kinds of crystals and glasses which arrest one series of waves while allowing others to pass through, little bits of the jigsaw puzzle provided by a "mystery ray" begin to fit together, not perhaps into a complete picture, but sufficiently to allow speculative fancy to play with material scientific possibilities.

The layman has accepted "broadcasting" as a commonplace. It is no longer a miracle of science but merely a bane or a convenience according to the opinion of the individual. But people do not realise that if the powers used in radiating "broadcast" are not dispersed throughout the ether, but localised and focussed, some sixty per cent. of the initial electrical energy emitted by the oscillator can be converted into heat.

Wireless transmission of power and heat are things which are rapidly approaching practical application,

and may materially modify both manufacturing and domestic conditions as we know them to-day.

In the United States, Dr. E. F. Northrup, Ph.D., has applied high frequency currents to a new type of electric furnace which will melt metals as refractory as platinum or iridium, and can handle steel or copper alloys on a commercial scale with furnace charges of several hundred pounds of metal.

The device is extraordinarily simple. A 220-volt 60 cycle oscillator which may be single or multiple phase, generates a current which is transformed to some 6,600 volts. This high frequency secondary current is discharged between two water-cooled iron electrodes almost touching a layer of mercury in a hydrogen filled box. Connected to each electrode is a condenser. From the opposing plates of these condensers leads are carried to the ends of a small circular coil of copper tube, which is the furnace helix. The connection between the secondary coil of the oscillator and this furnace helix is therefore not a direct electrical contact but an inductive contact from the opposing plates of the condensers. The apparatus is indeed very similar to an ordinary testa coil.

The copper tube helix is cooled by a current of water flowing through it, but does not heat to a point where the hand cannot be placed on it despite the fact that it is emitting enormous energy. The water serves not only to cool the helix, but in doing so keeps its electrical resistance low and facilitates the flow of current. Inside the helix is a cylinder of insulating material lined with heat insulating powder such as magnesite. This in turn is lined with graphite and inside the whole fits a clay graphite crucible containing the metal to be melted.

How it Works.

The generator supplies energy to the transformer until sufficient pressure is accumulated for a spark to jump across the mercury gap. When this occurs the condensers discharge themselves through the helix coil and set up an oscillatory backward and forward flow of current between ten and fifty thousand oscillations a second. If the helix was an aerial wire these energies would be radiated out into space but as it is a short closed coil the waves fall on the contents of the crucible and set up heating currents in the metal. The energy which is needed in order to produce extremely high temperatures is considerable and an input of 25 kilowatts is used in the commercial type of furnaces.

The scientific application of this kind of inductive furnace is that it enables the chemist or metallurgist to melt metals in a pure atmosphere uncontaminated by furnace gas and impurities or even in vacuum. The military applications of this high frequency inductive principle will let us hope be mainly defensive

rather than offensive owing to the difficulties of transporting powerful electric generating stations. But, unfortunately for humanity, the matter does not end with the evolution of a nice handy ray. Ingenious brains are probably already at work on an anti-ray device and with the evolution of a new electric weapon we shall see the evolution of new di-electric and refractory armour, ray shields for aeroplane magnetos and the like.

WELSH GOLD MINE DEVELOPMENTS.

THERE is quite a little boom in Welsh gold mining prospects, and the well-known gold-bearing area round Dolgelly is being made the subject of expert preliminary survey. In the past Welsh mines, notably the St. David's have yielded valuable if patchy results and rich pockets of native gold have been found from time to time. Recent research indicates that modern mining methods may be adaptable to large areas of low grade ore which was not worth while working on the older systems.

Welsh gold has a bad financial reputation in the City of London, and past promotions have been dubious. There is, however, no doubt that paying quantities of metal exist and in pre-war days it was an open secret that a well-known clubman made his annual income by retreating somewhere into the fastnesses of the Welsh mountains, and "panning" out a rich pocket of river gravel. He would return in the autumn to his club and frequently demonstrated a wash-leather poke substantially full of the takings. No one knew where he went, but there is reason to believe it was on somebody else's property, and that in the guise of a geologist or an angler he was able to make enough during a working holiday to support him modestly for the balance of the year.

ARTIFICIAL TIMBER.

No less than sixty per cent. of a tree is wasted in its conversion into lumber. At present the twigs, branches, bark, roots, sawdust and plank and log trimmings are entirely lost. A new process for the utilisation of these waste products and the production of synthetic lumber is being tried out in the United States. The process is a conversion of the waste into a cellulose compound of a plastic nature that can be pressed or moulded into all conceivable shapes and bulks from boards to rafters.

The development of the process has passed beyond the initial experimental stages and has been taken in hand by the National Lumber Manufacturers Association. If it is commercially practicable it may be extremely valuable as a step to the conservation of the world's timber supplies.

The Insect Bolshevik—the Mosquito.

By Arthur Waltham Howlett

Is the mosquito a menace to the Empire. The author points out how India, though mosquito ridden, is still free of Yellow Fever. A successful world flight or an unusually swift passage of the Pacific might land a Yellow Fever case in India and sow the germ of the American Yellow Fever in hitherto unaffected Asia.

THOSE dear old natural histories of our youth which used to describe not so much how an animal lived as how it ought to live according to human ideas, always ended up their descriptions with a peroration of simple profundity on the uses which the particular creature was intended to be to man. With animals like rats, for which it was difficult to discover a use in the economy of mankind, they adopted a non-committal attitude. Our simple-minded grandfathers never thought of reversing the argument, of picturing, for instance, what use mankind might be to rats. As to mosquitoes, they had never considered them; and people who took an interest in insects of any variety were merely "bug-hunters," and deficient in intelligence. None the less, these same "bug-hunters" have proved very convincingly at last that their ill-appreciated labours must have been directed by that blind—or seemingly blind—genius which orders the progress of mankind, and, in despite of its own improvident fecundity enables it to live.

It is to be hoped that the lesson will not be lost and that in future those who devote their lives to the study of objects which can bring them no gross material reward will, at least, not be made objects of ridicule by the unthinking and gain-set herd.

Curse of India.

A few years ago I spent a few days and nights in a mighty Indian city. I chose, on purpose, the time of the full moon, so that I might behold those ancient streets by night in that solemn and other-world splen-

dour which only the Indian moonbeams can bestow. It is true I stood by the door of my bungalow only and did not stir abroad, for those wide-ranging streets, once reechoing to all the pomp and stir of oriental life, were now but the haunt of panthers and snakes; and the inky shadows fell on grass-grown pavements and courtyards and silent

marble fountains which once had known the gay laughter of the beauties of a dazzling court. The ghostly silence that reigned in this city of the dead was broken by no human utterance, only the wild yells of jackal packs that dwelt by day in the empty houses gave emphasis to the brooding desolation. The Indians said it was accursed; and so it was, though not by Kali or Shiva or any other of their pantheon. Its curse was malaria brought by the myriad mosquitoes that bred in the surrounding swamps, those swamps which doubtless the Great Akhbār, at fault for once, had



THE RIVER JUMNA. ITS WIDE SHALLOWS ARE FERTILE MOSQUITO BREEDING PLACES, AND ALMOST IMPOSSIBLE TO TREAT WITH PREVENTIVE MEASURES.

designed to be one of the city's primary defences. Such was the city of Fatehpur Sikn; the city of victory, the cenotaph of an emperor's pride. He who had conquered all India was himself conquered by what—by the mosquito, that humblest of all instruments of avenging fate. So it was, too, if we may believe Mr. W. H. Jones in his "Malaria and Greek History," that Greece fell and became from its proud-est ornament one of the sorrows of the human race.

If other empires have fallen since, fate has found another tool, a mosquito in human guise, the deadly communist; but that does not oust the mosquito from its pride of place as one of the greatest factors in history in the older world.

But there is a great Providence that watches the needs of men, and now, having seen that the time is ripe, has unlocked yet another of its secret cupboards and opened a mighty storehouse of supplies. We build great halls and statues to the memory of popular soldiers, sailors and administrators, we lay their bones in ancient abbeys, we sing national dirges over politicians who spent their lives among the plaudits of the populace, but hardly a voice has been raised as yet to honour those who in patient obscurity and self-denial have laboured to throw open to mankind the vast treasury of the tropics.

Scientific War.

How long and deadly has been the warfare with tropical diseases few realise who have not studied them, a warfare in which we were ever bested because our "Intelligence" was hopelessly at fault; until, in a glorious flash of inspiration, certain army surgeons made the discovery that it was nothing more than the humble mosquito that was our arch and secret enemy, that it was she, and she alone, who had brought about the downfall of empires and slain hundreds of thousands more of human beings than all the wars in history.

For, of all causes, malaria ranks as the most potent death dealer in the universe even to-day. Yet there is another terror of which the mosquito is the author; though not so widespread infinitely more deadly. Like malaria, it looks like another check to sinful man, for it followed in the wake of the grim slave traffic, that ghastly cartage of human beings from Africa to the Spanish Main. It is only since the discovery, on the analogy of the etiology of malaria, that Yellow Fever is also a mosquito borne disease, that it has been possible to take measures for its suppression. At one time, even in our own fathers' days, it was one of the deadliest scourges on earth and converted into a hell those fair West Indian islands which nature had made a paradise. The records of old regiments

ordered to the West Indies make terrible reading, and a soldier ordered there fifty years ago stood less chance of returning home than from the bloodiest of Continental campaigns. So, to come to later history, the gallant endeavours of the French to complete the Panama Canal were frustrated entirely by this mysterious and apparently unconquerable disease. Millions of pounds worth of costly machinery was left to rust in the jungle, thousands of lives sacrificed, and a noble enterprise relinquished through failure to recognise this tiny but potent enemy. And without detracting from American glory, it is indisputable that it was as much by the efforts of medical men as by the engineers that the triumph was finally achieved.



THE PORT OF KINGSTON, JAMAICA, ONCE A DEADLY YELLOW FEVER TRAP, BUT NOW ALMOST IMMUNE.

And a word now about the lady herself, for she justifies, alas, the Kiplingesque dictum that the female of the species is more deadly than the male. The male mosquito is a polished and, I might say, ornate gentleman, for not only has he beautifully feathered antennæ, but his manners are suave to a degree. He feeds only on vegetable juices, the Eustace Miles restaurants in the jungle are good enough for him. But his spouse must have blood. Without blood she cannot lay her eggs. With asperfection of wickedness

she has no sooner made a meal of blood than she proceeds to deposit her infamous brood and rear another progeny as wicked as herself.

Mother Mosquito.

With a craft that might be admirable, were it less ill-meant, she makes her eggs into a bowl-shaped raft which floats like a coracle on the water. She favours weed-grown borders, for there the small raft which represents her nursery is protected from rough water; or else she lays in some small collection of water such as you may find after the tropic rains in an old tin or crock. The eggs hatch after a few days and the larvæ swim as aquatic creatures in the water breathing air by means of a tube, which they

project above the surface film like the periscope of a submarine.

A study of the bionomics of the mosquito suggests the means of its destruction. These are obviously directed to excluding her from water in which she can deposit her eggs or else in destroying the larvæ in such water as she has obtained access to. Measures to these ends have been carefully elaborated and form the basis of so-called tropical sanitation. In many countries like India where the natives are secretive and obstinately indifferent they are often difficult to enforce, but where an authority can exercise its full vigilance and ensure compliance, these measures make all the difference between a death trap and a health resort. Panama and Havana, not long since two of the deadliest spots on earth, have now been converted to tourist playgrounds and have a smaller death rate than New York itself.

Other Insects.

Varieties of mosquitoes run into hundreds and there are many more to be discovered by the entomologist sighing for fresh worlds to conquer. They are differentiated and classified largely by the markings on the wings, the differing lengths of the palpi and by

their resting attitudes. Not all carry diseases fortunately, and, of course, not all those that are vectors of disease are infected, since they must bite a victim of the disease before they can withdraw the virus from his blood and inject it into the next individual they happen to bite.

A Menace.

And we have only opened up the problems of this new discovery. The very opening of the Panama Canal, for example, has itself raised a new danger in the possibility of the transportation of Yellow Fever from that zone, where it is endemic, to India. For in India the particular mosquito that carries Yellow Fever is already existent, and it only needs the escape of an infected patient on to Indian soil to light up an epidemic of unpredictable proportions. Before the Canal was opened the lengthy voyages of ships and the cold latitudes they had to pass through were sufficient safeguards, the time occupied in the voyage being outside the developmental period of the disease. A special Commission of the Indian Government considered the menace and all precautions are adopted to obviate the danger.

New Light on the Origin of Petroleum

By A. S. Wilson-Jones, B.A.

OF the various theories of the origin of different petroleum deposits to be found in several parts of the world, the "vegetable" theory has been gaining ground among petroleum chemists and technologists in recent years. According to this theory it will be remembered that mineral oil deposits are supposed to be derived from immense deposits of vegetation which have become metamorphosed in the course of ages through the agency of heat and pressure. The formation of oil deposits is thus thought to be somewhat parallel to the formation of coal, and there are a variety of reasons in favour of this theory which have been summarised by various writers. Incidentally, one of the most recent books on this subject which may be recommended to those interested is "The Genesis of Petroleum" by Dr. Percy Spielman,* who favours this theory as against the "mineral" theory first advanced by the Russian chemist Mendelejeff according to which the interaction of volcanic steam with certain rather hypothetical carbides has produced the various hydrocarbons composing oil deposits. There is also

a third theory on which the oil is derived from fish remains in a similar manner to that postulated in the vegetable theory which it closely resembles.

It may perhaps be questioned whether any reliance can be placed on the scientific investigations of the Russian Soviet Government, but in the absence of any evidence to the contrary there would not seem to be any reason to doubt the results of a recent investigation of a certain kind of slime which occurs in various lakes in Turkestan and European Russia. This slime, which is known as "sapropel," is formed by the decomposition of vegetable matter, and the Russian investigators report that this has been found sometimes in a semi-bitumenised state, which on distillation gave virtually every distillate usually associated with petroleum deposits. In addition the tarry residue from this distillation is similar to that remaining after the distillation of petroleum, so that the evidence afforded in support of a vegetable origin of petroleum appears very strong indeed. It is interesting to note in this connection that Pontaine many years ago suggested that this slime formed at the bottom of lakes was a possible origin of petroleum.

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A Review of Science for the Month.

By G. D. Knox.

We introduce a new feature which within the limits of its space will afford readers of "Discovery" a resumé of the current scientific happenings of the month.

As invariably in May the most striking event of the month has been the annual *Conversazione* of the Royal Society. The exhibits were remarkable, particularly for the extent to which they showed the steady progress which is being made in equipping engineers and others with accurate means of making measurement, which entail far less cumbrous operations than those which formerly held the field. Marine engineers in the old days frequently found themselves compelled to crawl along uncomfortable shaft tunnels in order to investigate the strains to which the propeller shaft was exposed, but the Cambridge Instrument Company exhibited to the Fellows of the Society an instrument working on an electro-magnet principle, which enabled the engineer in his room or the captain on the bridge to read directly from a simple dial the exact force being exerted at any given moment through the shaft.

New Vacuum Pump.

The National Physical Laboratory was particularly well represented, and had on view a very beautiful All-Metal Annular-Jet Vacuum Pump, the work of Dr. Kaye and Mr. Backhurst. The pump works at an abnormally high speed, and is capable very rapidly of producing a vacuum of 0.00001 mm mercury, when working against a back pressure of 1 mm mercury. It has many advantages, among these being the fact that it is made of metal and has no parts liable to fracture, and is therefore readily portable. It can be used to obtain any desired degree of vacuum and operates by means of the condensation of mercury vapour. Other exhibits for which the National Physical Laboratory was responsible, an electrical method of hardening the essential parts of standard gauges and a means of measuring the correct amount of daylight that should be admitted normally into factories and dwelling houses.

Of the spectacular demonstrations—leaving out of account the set discourse pronounced by Mr. F. E. Smith, the Director of Scientific Research at the Admiralty on "Modern Navigational Devices," and illustrated by experiments—the most striking was one shown by the Research Department of the Anglo-Persian Oil Company, which demonstrated how lightning could be made to strike in a way that suited them, thus preventing destruction of their plant. Experience

having shown that ordinary lightning conductors were not effective in protecting oil tanks, they discovered that a tall spiked rod fifty feet high, gave ample protection to oil tanks within a reasonable distance of it. The method was illustrated by a source of high tension electricity that moved over a set of model tanks, protected by lightning conductors. The sparks, as it discharged, hit tank after tank, but when a high spiked rod was placed in the centre of them this distracted the discharge to itself and the tanks all escaped.

In biology, Sir Almroth Wright, Mr. Fleming and Mr. Colebrook were out to shatter shibboleths. They exhibited new methods for the exploration of bacterial disease and for the study of the effects of treatment. If the results are accepted and the cultures made in blood were visible to the naked eye at the Royal Society *Conversazione*, many reforms will have to be made in practice. It is claimed that when quinine is injected into the blood stream, it so weakens the natural defensive organisms of the body, that it actually facilitates the progress of the disease it is intended to cure, while if carbolic or other strong chemical disinfectants are placed on an open wound, they produce the same effect, and thus retard the normal process of healing that Nature always endeavours to effect.

Boron and the Beanstalk.

Other interesting exhibits included cultures of fungi causing dry rot in buildings (Professor P. Groom); the division into two of one living cell every twenty minutes (M. T. S. P. Strangeways); the remarkable effects of traces of boric acid in increasing plant growth (Rothamsted Experimental Station); and a method of arranging for a neon lamp so to blink as to measure accurately and if necessary photograph waves of very high frequency (International Western Electric Company).

There is a tendency for learned societies to prolong the Easter recess well into May, but the Royal Institution opened to the public before the beginning of the month, and has provided an interesting programme, the most topical of the series arranged, in view of the projected ascent of Mount Everest, being that by Professor Barcroft on the Effect of Altitude on Man. Of many interesting conclusions, perhaps the most striking was the way in which the thoracic cavity is

developed, a mountaineer of five feet two inches having as great a thoracic capacity as that of a plain-dweller six feet high. Professor Barcroft preferred to make no definite statement as to whether this character was inherited or was developed in the course of growth.

In connection with the vexed question of the inheritance of acquired characters, mention should be made of the bombshell thrown by Sir James Crichton Browne at the Montessori Imperial Conference held at Wembley. He described Pavlov's recent experiments on mice, pointing out that he had trained a group of white mice to run to their feeding place on the ringing of an electric bell. Three hundred lessons were required in the first instance to accustom them to run to the spot when the bell rang. In mice, however, bred from the mice thus trained, a much higher aptitude was displayed, for only a hundred lessons were necessary to obtain the same result. The third generation required only thirty lessons and the fourth only ten. The last generation learnt their lesson after only five repetitions, and Pavlov has expressed the opinion that a later generation will run to the feeding place on the first occasion of hearing the bell. Sir James Crichton-Browne argued that these experiments overthrew the Weismann refusal to admit the possibility of the inheritance of acquired characters, and used them as a fresh argument in favour of the value of education. The upholders of Weismann will require a very heavy attack before they will begin to think of abandoning their position.

Biological problems had the chief place in the proceedings of the Royal Institution in the early part of the post Easter session, but towards the end ample amends were paid to physics and chemistry, with Bjerknes on the forces which lift aeroplanes, Appleton on atmospheric disturbance in wireless, Bull on recent developments in high speed cinematography, Tucker on acoustical problems and Rayleigh on the glow of phosphorus.

New Laboratories.

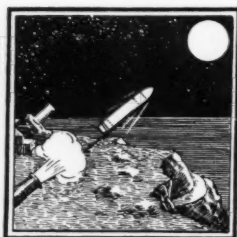
An important instrument for the promotion of scientific advance was forged on the ninth of the month, when the Earl of Balfour, the Chancellor of Cambridge University, formally declared open the recently completed Sir William Dunn Laboratories in which the Cambridge School of Bio-chemistry is now housed. Professor Gowland Hopkins is in charge of the school, and it is significant, perhaps, that the Chancellor, in declaring the building open, referred to cancer, the scourge which had for many years defied the utmost clinical efforts as being one of the urgent fields of work

which might well yield up its secrets, to the immense benefit of humanity in such a laboratory.

Few scientific experiments have so thoroughly fired the imagination of the public as the explosions organised by the French Government at La Courtine in the centre of France. The honour of originating the idea belongs to Professor de Quervin of Zurich. He suggested, shortly after the termination of the war, that some of the huge stocks of explosives should be utilised for the purpose of studying how sound is transmitted through the atmosphere. The first experiment was carried out at Oldenbroek in Holland, and this gave a number of curious results. In one direction the sound was heard for only twelve miles from the site of the explosion, in another for forty miles, then there were zones of silence and the explosion again became audible at varying distances, having as limiting figures 450 and 350 miles. At the time of going to press it is too early to say anything definite about the result of the French explosion. Reports have been received of low rumbling sounds, but in many cases the low rumbling sounds were heard either too soon or too late to have any relation to the explosion. A theory to explain the zones of silence is that the sound as it travels along the earth's surface, dies out eventually through friction, the point of dying out marking the beginning of a zone of silence. Waves of sound, however, also travel into the upper air and are there "refracted" back to earth, striking the earth's crust and starting a new zone of sound.

Toronto Meeting.

Members of the British Association have already taken their tickets for Canada, and have decided to attend the Toronto meeting to the number of about 600. The date for the opening ceremony has been fixed for August the sixth, when the new President, Sir David Bruce, will deliver his address on the advances in the knowledge of disease and the means of coping with and preventing it, with special references to preventive measures used during the war. There are to be joint discussions between the section of Mathematics and Physics, over which Sir William Bragg is presiding, on crystal structure and on colloid solutions. The physicists will also meet with the Engineering section to consider optical stress determinations. Chemistry is joining hands with Physiology and Agriculture to discuss vitamins and with Geology to discuss liquid and other fuels. Such are only a few of the discussions arranged. There is nothing at present approaching to a complete programme of papers, but the names of those who are attending are a guarantee that the meeting will be quite up to British Association standards.



Professor Goddard's Rocket to the Moon

By Hugh Pollard.

The Smithsonian Institute is supporting the Professor in his attempt to land a terrestrial projectile on the moon's surface. The experiment is engaging the attention of some of the leading scientific brains of the western hemisphere, and if successful will be one of the most sensational feats of modern science. It is a bold idea and despite enormous difficulties not impossible of success.



FOR several years Professor R. H. Goddard of Clark University, Worcester, Mass, has been planning to shoot a giant rocket at the moon. This summer, state recent advices from America, the attempt is going to be made. Even if it does not succeed it is a very sporting attempt at the greatest ballistic experiment ever conceived.

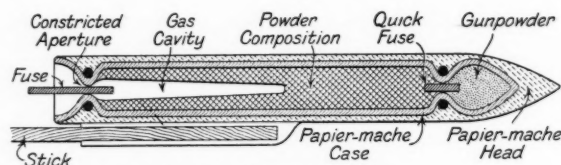
So far the longest range guns known to have been constructed have only a range of some one hundred and twenty miles. This type of weapon was used for the long-range bombardment of Paris by the Germans. It is, however, understood that artillery experts have already worked out plans for guns of almost twice the range and with a far greater computed capacity for accurate shooting. Goddard's projectile is rather different, for though a gun or some direction-giving appliance will be needed to launch it, at the same time it contains its own store of propulsive energy and is a composite shell-rocket.

It is curious that the latest idea in scientific ballistics should be a return to the rocket for this was probably the first type of explosive projectile used in warfare. The Chinese used rockets from time immemorial and Alexander the Great met with something of the kind when he invaded India. In actual practice the Chinese rockets were bamboo or paper cases just like ordinary firework rockets but the head was armed with a barbed arrowhead, which probably served two purposes, being both penetrating and also valuable in helping the missile to cling to a stockade or the roofs of houses and so develop its incendiary value.

Early Projectiles.

The Greek fire projected from brazen tubes in the bows of galleys in the seventh century A.D. was also probably an application of the rocket principle and the "petraries" described by de Joinville as in use at the Crusades undoubtedly projected an elementary form of rocket. It is entirely probable but yet unproved that the early cannon originated from these appliances for projecting combustible mixtures by means of the gases developed by their own combustion.

In essence the principle of the rocket differs from that of a projectile discharged from a gun in that while the powder charge of a gun is a separate unit whose purpose is to transmit sufficient initial velocity to the bullet or shell to cast it a sufficient distance, a rocket has no initial powder charge behind it but contains its own slow burning charge the gases of which impinging on the atmosphere and on the base of the rocket maintain its velocity while it is in flight. No gun or mortar is necessary to fire a rocket from, but in practice they are discharged from tubes or troughs in order to have an initial guidance in the desired direction.



Section of Common Rocket
FIG. 1.—SECTIONAL DIAGRAM OF COMMON ROCKET.

The diagram (fig. 1) shows a section of a common rocket. The papier mâché tube is filled with powder composition made of compressed meal powder, which has the same ingredients and proportions as common gunpowder, but unlike the latter is not granulated. This meal powder burns a great deal more slowly than gunpowder, so the gases given off though violently expelled are not developed swiftly enough to cause a true explosion. The formula for both meal powder and black gunpowder is the same, 75 parts of potassium nitrate to 10 of sulphur to 15 of carbon. The KNO_3 supplies its own oxygen to the action and one gramme of powder generates 264.6 cc of gas at 0°C . As the heat of combustion is intense the actual volume of gas generated is enormous.

Gas Pressure.

In order that as great a surface of composition may be ignited at once a hollow cone or gas chamber is moulded in the block of composition and in order to

restrain and focus the gases of combustion the base of the rocket is constricted after it has been filled so that the gases must pass through a narrow neck. The head of the rocket contains a small bursting charge of loose black powder and coloured stars or signal compositions. This is separated from the propelling chamber by a similar constriction so that the flame does not reach the bursting charge until the rocket has used up all its propellant and reached the zenith of its flight. Then the flame passes through a short quick match or hole and fires the bursting charge which blows open the head and releases the ignited stars.

There have been relatively few improvements in rockets since the Congreve war rocket was developed in the early nineteenth century and used in the attack on Boulogne, 1806, and at Copenhagen in 1807. The main development was the abandonment of the stick or guide and the substitution of a metal base with three or more spiralled vents so designed that they turned the rocket into a kind of primitive turbine and gave it the necessary axial rotation to endow it with some measure of accuracy.

The war rockets were used in the British Services until the last decades of the century, but mainly for frontier and African bush warfare, in countries where artillery was hard to transport and the fear-provoking qualities of the fiery weapon were more valuable than its limited bursting effect. Early in 1914 experiments were again carried out with a view to their use in trench warfare, and the original 2½-inch "Xmas Pudding" Vickers trench mortar was first designed as a rocket-gun, then modified to take trench bombs.

The reason that the rocket was abandoned as a weapon was because no one has yet found any means of making it even moderately accurate. Windage effects are prodigious and incalculable and under certain conditions even rockets fired with a high muzzle velocity will "boomerang" in mid-air and come back overhead landing as likely as not close to the battery.

Some of the Problems.

Now let us consider the task before Professor Goddard. He has a large target 2,160 miles in diameter but it is 240,000 miles away from the earth. The first problem is how to get it beyond the field of the earth's gravity, and here physicists agree that provided a body has an initial velocity of about 35,000 feet per second this will be achieved. Goddard claims his projectile will be launched with an initial velocity of 6.6 miles per second and that it is provided with a mechanism for firing successive charges which will continue to drive it through space until within the zone of the moon's gravitational pull, when, although

the propellants are exhausted the moon itself will pull the projectile to the target.

This question of initial velocity raises interesting problems, for the muzzle velocity of few pieces of ordnance exceeds 3,000 feet per second and the m.v. of most military rifles is round about 2,700 feet per second. The m.v. of the long-range guns used in the war is not definitely known but was estimated to be in the neighbourhood of 7,000 f.p.s. No particulars are available concerning the launching mechanism to be used with Goddard's rocket, but it is said that

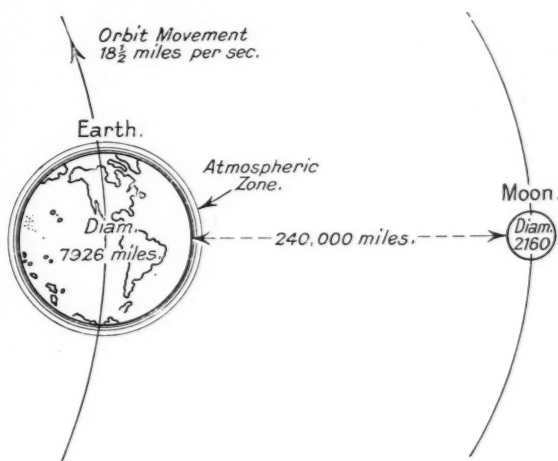


FIG. 2.—If two discs of paper the size of the above circles are placed 3 feet 10½ inches apart, you will gain an approximate idea of the task in marksmanship Professor Goddard is facing.

the actual propellant in the rocket itself will be a liquid fuel burning in combination with liquid oxygen stored in the projectile.

Another account states that the apparatus is a double or multiple rocket which, ascending by successive repeating impulses, discharges the second or moon-destined projectile when a certain height has been attained and the density of the atmosphere is sufficiently reduced. Judging from the few illustrations which have appeared showing Professor Goddard and his invention, something of this kind is contemplated, and a balanced vacuum valve in the moon rocket probably comes into play when the main projectile has reached sufficiently rarefied air. This mechanism probably fires the propelling charge of the moon rocket and releases it from the sturdier host or carrier rocket to complete its journey on its own.

Whether the carrier is a true self-propelling rocket rising from earth on its own propulsive charge or whether it is to be a hybrid, part rocket—part projectile, fired from a gun or howitzer, is not disclosed. Experiments are said to have been made under the auspices

of the Smithsonian Institute with models of this repeating rocket nature and they are satisfied that the scheme is worth proceeding with.

Mystery Mechanism.

The whole rocket is said to be cigar-shaped, some five feet high, and the pictures of the internal mechanism of the moon rocket indicate a height of some two and a half feet and a calibre of six inches.

On reaching the moon the rocket-head, which will hold three pounds of magnesium powder similar to that used in flashlights by photographers, will explode on impact and this will make a flash large enough to be visible by observers watching the lunar surface in a 12-inch reflector telescope. This powder too

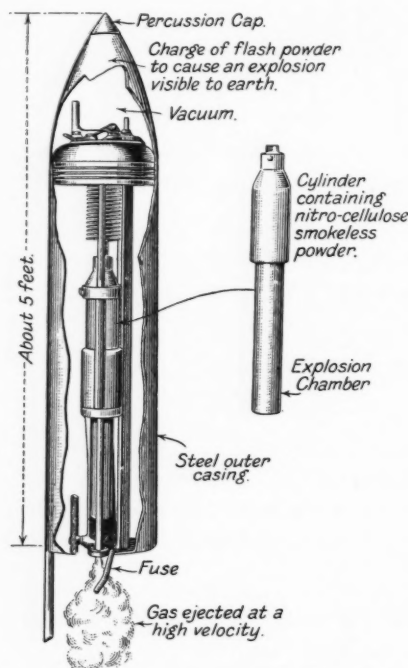


FIG. 3.—SECTION OF GODDARD ROCKET IN ITS ORIGINAL FORM.

contains in itself the necessary oxygen to effect combustion, so that even if the moon's atmosphere is different to that of the earth—and some astronomers claim that the moon has no atmosphere—the burst will still occur. It will too be fired at the area of darkness, where the moon is in its crescent phase, so that the flash may be easier seen against the dark background.

The difficulties of the experiment centre mainly round the task of getting outside the sphere of Earth's

influence, and Goddard's rocket stands almost as much chance of landing in Main Street, Minnesota as it does of hitting the moon. Yet—it is a great experiment and one well worth trying. If it succeeds, and it is not by any means impossible that it should, we shall have opened the way to further knowledge of our nearest inter-spatial neighbour. We may speculate about life on the moon—vegetation is suspected, Professor Pickering believes there is an occasional snowfall—but there is no detectable sign of any organised life such as lunar humanity or a race of giant building insects—man-sized ants might construct. If there were towns our modern astronomical telescopes would detect them.

Still, if Goddard succeeds and all the elaborate calculations to outreach the Earth's pull and the lateral drift of rotation are successful, we shall be able to bombard the moon with rockets containing charges of different natures.

A fantastic realm of speculation opens. If we find that life can exist on the moon, what shall we bombard with—seeds of terrestrial plants? Could they survive the 14-day "day" of heat and the equally long night of probably sub-zero cold. Yet—who knows—if Goddard is successful — !

AEROPLANES AND ARCHÆOLOGY.

RECENT researches in Tunis have shown the value of the seaplane for locating sunken wrecks of galleys. Last year a wreck previously located by sponge divers but then again lost sight of was again found, and this summer further searches are to be made in the hopes of finding some of the galleys lost in the sea engagements off Carthage.

It is possible, though improbable, that in this way we may recover the original Treasures of the Temple of Jerusalem which was looted from the sack of Rome were sunk off Carthage.

In Syria and Trans-Jordania the aeroplane has helped archaeologists to pass the waterless deserts and the sites of Opis and Sittace, lost cities mentioned in the *Anabasis* of Xenophon have been sited some fifteen miles away from the present bed of the river Tigris. Observation from the air enables the ground-lines of old walls to be picked up with the greatest ease.

* * * * *

The latest idea in indoor aerals is a double coil of spring wire with an insulator at each end. This device can be stretched from point to point in a room or out-of-doors in confined spaces and is claimed to be more effective as a current collector than a single wire of equivalent length from point to point.

A Jewish Community in Egypt in the Fifth Century B.C.

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool.

Recent discoveries disclose that the earliest known Jewish document but one has been found among a bundle of Aramaic papyri. It contains references to Ezra and Nehemiah, the contemporary prophets, and discloses that the Jews of this particular community were not monotheistic although not schismatic. They apparently possessed a local temple of their own despite the centralisation of the religion in one temple at Jerusalem.

IN 1904 a number of fragments of Aramaic papyri were acquired by a British archaeologist from a dealer in Assuan, the ancient Syene. They proved to have come from the ruins of Elephantine, which lie on an island in the Nile opposite Assuan, and here German archaeologists carried out systematic exploration of which the principal results were published by Sachau in 1911. The documents are written in the North Semitic dialect which is known as Aramaic and they belonged to a community of Jewish soldiers who were stationed at Elephantine during the fifth century B.C., when Egypt was under Persian rule. They consist mainly of letters, legal documents, accounts and lists of names, but include two literary pieces of some interest. One is a copy of the Behistun inscription of Darius I, which is famous partly because of its intrinsic historical value as the official account of Darius' reign as issued by himself and partly because it was written in three languages and thereby supplied the key to the decipherment of cuneiform. To find a copy of this document is fortunate but not surprising. The cliff at Behistun was selected more with an eye to securing permanence for the record than to broadcasting its contents to contemporaries, and the inscription itself tells us that Darius sent out copies throughout his empire. A part indeed of one such copy inscribed on stone in the Babylonian language has been discovered at Babylon.

The Aramaic Language.

Our papyrus is from internal evidence a copy of a worn Aramaic text, which may have been the original version which Darius sent into Egypt. The other literary text, *The Words of Ahikar*, is a discovery of the very first importance to students of popular and proverbial literature. To deal with it, however, would demand a paper in itself and I must here content myself with trying to indicate the historical and general interest which attaches to the glimpse afforded by the main body of the papyri into the conditions of life in this Jewish community.

A word may first be said about the language in which the texts are written. Aramaic had long been the *lingua franca* of the Middle East. It will be generally

known that the local scarcity of more convenient writing material led to the development in Mesopotamia of the script which is called cuneiform, from the Latin *cuneus*, a wedge. Wedge-shaped marks were incised in soft clay, which could then be given permanence by baking the tablet into brick. For the archaeologist this has proved an admirably enduring method of making records but for contemporaries it had its obvious disadvantages in ordinary practical life. Except locally the papyrus roll was bound eventually to supersede the clay brick. But the script developed for incision in soft clay was not suitable for writing upon papyrus and in consequence Aramaic, perhaps originally the language of trade, for reasons of practical convenience came to supersede Babylonian in diplomacy. When the Persians became masters of the Middle East in the second half of the sixth century, they found Aramaic already the recognised *lingua franca* of the area and they adopted it as the official language of their empire. Persian itself came to be written in Aramaic characters and this was the origin of the so-called Pehlevi script. Indeed, until Aramaic was superseded by Greek under the successors of Alexander the Great, it remained the official language of the Middle East. The writers of our documents are Jews and their names are Hebrew but the texts are all written in Aramaic and there is no evidence that any other language was employed by them in daily life. Aramaic not Hebrew was their ordinary speech. But with the exception of one inscription and of a few inscribed potsherds, these papyri are the oldest Jewish texts in existence and, except for the Old Testament, the oldest Jewish literature which we possess.

The Mercenaries in Egypt.

The writers of these documents refer to themselves as "The Jewish force at Yeb (i.e. Elephantine)." They were organised in companies under Persian officers, and the regular way of describing an individual in legal documents is "A the son of B of the company of X." They were members in fact of an hereditary military colony, if we may use the word in the Roman rather than in the Greek sense, and formed part of

the garrison of this frontier fortress which was the key to the defence of Egyptian territory on the south. In one of their letters they claim that their temple was built in the days of the Egyptian kings and that it was spared by the Persian conqueror Cambyses, when he destroyed Egyptian temples. The Jewish detachments were therefore stationed in Elephantine before the Persian conquest of Egypt in 525 B.C., and were simply taken over by the new masters of the country. When and how did they come to be there?

Of course, other Jews besides the prophet Jeremiah fled into Egypt after the capture of Jerusalem in 585, but these refugees settled mostly in the Delta. Though they may have added recruits to the Jewish garrison in the extreme south neither they nor the political refugees of the preceding years, when the rivalry between the Egyptian and the Mesopotamian parties in Jerusalem was acute, can have supplied the occasion of the original enlistment of the corps. Now there is a verse in *Deuteronomy* (xvii. 16) which has puzzled commentators but, as Eduard Meyer has indicated, at once explains and is explained by this hereditary Jewish detachment.

Monotheism.

Deuteronomy is the official expression of the centralising religious reform of Josiah in 621 B.C. The idolatrous religious practices of the Jewish folk were to be superseded by a true monotheism. Worship was to be centralised in the Temple at Jerusalem and even here it was to be purified by the abolition of idolatrous elements. *Deuteronomy*, in fact, is the forerunner of the yet more stringently theocratic and equally monotheistic religious system of Ezra and Nehemiah. The purification of religion was to guarantee the success of an independent and vigorous foreign policy, but in fact this resulted in speedy disaster at Megiddo where Josiah was decisively defeated by Pharaoh Necho in 608. How far Josiah's religious reforms were ever effectively enforced in Palestine as a whole it is difficult to say. The disillusionment of national aspirations at Megiddo may have discredited the religious change and the complaints of Jeremiah suggest that with regard to the purification of religion in Palestine all that had been hoped by the prophets had not been realised. The question concerns us because, as we shall see, the religious practices of the Jewish community at Elephantine suggest that they had been untouched by the legislation of *Deuteronomy*. By itself this does not establish the fact that their fathers enlisted in Egyptian service before 621, because we do not know how complete was the effectiveness of Josiah's legislation, but it makes it not improbable. Now the verse above referred to runs, "Only he shall

not multiply horses to himself, nor cause the people to return to Egypt, to the end that he should multiply horses." Meyer suggests that this is an undertaking by the king that he will not continue an existing practice of exchanging Jewish mercenaries for Egyptian horses.

National Triumph.

Let us turn to Egyptian history. In 645 the Saite prince, Psamtik I, whom the Greeks called Psammetichus, united Egypt and drove out the Assyrians, who under Assarhaddon had conquered the country a quarter of a century before. His war of liberation owed its success mainly to the assistance of large numbers of mercenary troops. For Greek civilisation this was of some importance. It was to the interest of Lydia, the power which had recently asserted its control over Western Asia Minor under the able usurper Gyges, to help the enemies of the dominant great power in the Middle East and through Gyges Psamtik acquired the help of Ionian and Carian mercenaries, the "men of bronze" of subsequent tradition. As a result the triumph of the national cause opened Egypt to the Greeks.

The mercenary army which had defeated the Assyrians was retained by the successful dynasty. Apart from foreign wars, internal conditions made them indispensable; for the untrustworthy Egyptianised Libyans, the "military caste" of Herodotus, who had dominated Egypt before the Assyrian conquest, much as the Mamelukes many centuries later were to do, required firm handling. It was Psamtik I, who founded the fortress of Elephantine to guard the southern edge of Egypt. I do not think that there is any evidence that he employed Jewish mercenaries or stationed them there. But it is not improbable. There is evidence that Psamtik II, his next successor but one (594-589), employed Jewish mercenaries upon his Ethiopian expedition and one at least of the Greek mercenaries who took part in it was the son of one of the original "men of bronze" enlisted by Psamtik I. Two corps, one of native troops and one of foreign mercenaries but both commanded by Egyptian officers, embarked at Elephantine and explored the river between the First and Second Cataracts. On their way back they passed the great temple of Abu Simbel in Nubia and upon the legs of one of the colossal statues in front of it the soldiers, after the way of Tommies in all centuries, scratched their names. The officer commanding the Greek contingent of the mercenaries was Psammetichus the son of Neocles and it can hardly be doubted that Neocles was one of the Greek mercenaries, who took part in the war of liberation, continued in the Egyptian

service and named his son after his royal master. It is therefore not improbable that the Jewish troops who took part in this expedition similarly represented the second generation of mercenaries enlisted by Psamtik I.

Pre-Exilic Judaism.

If our Jews left Palestine in the seventh century we should expect their descendants to represent the tradition of pre-exilic Judaism rather than that of Ezra and Nehemiah. This indeed is the paramount interest of the documents. For contemporary events it is true they are of great value. They several times refer to persons already known to us in Ezra and Nehemiah and they are a striking vindication of the authenticity the memoirs and documents upon which those books are based. But their paramount interest lies in the statements and omissions with regard to religious matters, which show how very different was the religion of the Jewish folk in pre-exilic times from the lofty monotheism preached by the prophets.

The community at Elephantine is typically Jewish in its solidarity and its adherence to national and religious custom. Everywhere and always the Jews have been a peculiar people. The papyri mention cases of intermarriage with Egyptians but there is reason to believe that those who married into the community embraced Judaism. Clearly there was friction with their neighbours who indeed organised a pogrom and destroyed the temple of the Jews. The true cause of this dislike I suspect to have been that social aloofness which led such different people as the Roman historian Tacitus and the XVIIth century Turkish traveller Evliya to dislike them as "haters of the human race."

Polytheistic Community.

The community was governed by a headman and the priests. But the priests are not apparently Levites. There is throughout no mention of the sons of Levi or the sons of Aaron. Nor is there any evidence that they possessed, administered or were acquainted with the law of Moses. The Sabbath is nowhere mentioned. There is one curious reference to the Feast of Unleavened Bread and the Passover, a document in which their observance is ordered by the Persian king. The explanation, however, of the necessity or occasion for this edict is a matter of some difficulty and dispute. "Meal-offering and incense and sacrifice" were offered at the altar of their temple and after its destruction they ask permission to rebuild it and to resume its ritual. Permission was granted except as regards animal sacrifice. This was probably prohibited because of the Zoroastrian objection to

the defiling of fire by contact with dead bodies and not, as was first suggested, in order to avoid offending Egyptian susceptibilities, for Egyptians themselves practised animal sacrifice. The possession of a local temple at all is remarkable. A cardinal feature of the programme of the religious reformers in Palestine was the suppression of all local shrines and the centralisation of worship at the temple at Jerusalem, "the place which the Lord shall choose" (*Deut.* xii. 26). But the Jews of Elephantine are not schismatics; they are conscious of no guilt in the matter; they even appeal to the High Priest at Jerusalem for help to rebuild their temple, an appeal which naturally enough was ignored. But their innocence extends yet remarkably further. Though it is not certain that they were idolaters, they were quite certainly not monotheists. They worshipped, indeed, a single god, Ya'u or Jehovah, as their national deity, but recognised lesser deities as well. Nor are these accretions which had come to them from foreign sources since they left Palestine. 'Anath was at home near Jerusalem where her cult is attested by the place-name Bethany. She is apparently regarded as the consort of Ya'u and is perhaps a form of the Queen of Heaven to whom the Jewish women of Egypt in spite of Jeremiah poured out drink offerings "as we have done, we and our fathers, our kings and our princes, in the cities of Judah and in the streets of Jerusalem" (*Jeremiah* xlv. 17). Ishum, again, is most probably to be identified with the Samaritan divinity Ashima. Two other divine names, Bethel and Herem, also occur in oaths and in proper names.

Names of Strange Gods.

The first is primarily the cult fetish or baetyl ("the House of God") of Semitic worship; the second, according to Meyer, means the "dedicated area in which the baetyl stands." It is perhaps doubtful whether we should call these gods in the same sense as 'Anath and Ashima, though they seem to have been invoked as the powers inherent in these holy objects. We might perhaps compare an invocation of the Rood in a mediæval oath. In any case I think that Cowley's suggestion of a connection between *Isaiah* xix. 19 and Elephantine, where he suggests that the temple had five gates and five gods, cannot stand. Another oath is sanctioned "by Ya'u, by Mesgid, and by Anath of Ya'u." Mesgid, which later in Arabic became the word in ordinary use for "mosque," means "the place of prayer." If we call Bethel and Herem gods, I think that we must call Mesgid a god also, with the result that we must recognise six not five divinities at Elephantine.

Some Phenomena of Phosphorescence.

By J. S. Dow.

Very little recent work has been done in this particular line, and this article is written to draw attention to a field of research needing little apparatus and open to the scientific amateur. If man could generate light as economically as the glowworm, modern lighting conditions would be revolutionised.

"LUMINESCENCE," "Phosphorescence," "Fluorescence,"—rather formidable terms used to describe phenomena which can be demonstrated by quite simple means. "Incandescence" occurs when bodies are heated to a temperature so high that they emit light—the filament of an electric lamp, the oil, gas or acetylene flame, are instances of this process. "Luminescence" is generally used to describe the production of light by other means; for instance, the electric discharge through rare gases and metallic vapours results in light—a vivid orange in the case of the new neon tubes, green in the case of the mercury vapour lamp. In a previous article in DISCOVERY the author has given reasons for hoping for ultimate improvements in the efficiency of light sources by this means, as well as greater control of the colour of light emitted.

Field for Experiment.

It is now proposed to deal with a different form of luminescence—the curious effects somewhat loosely described as "phosphorescence." Here again a distinction is drawn by men of science. Effects which occur only whilst a stimulus is applied are more properly described as "fluorescence"; but if the effect persists after the stimulus is withdrawn this is "phosphorescence." The distinction is somewhat indefinite, however. Probably all materials are capable both of fluorescence and phosphorescence if the stimulus is sufficiently intense, though the degree and duration of the latter may be so small as to render it almost imperceptible.

One of the most familiar examples of fluorescence (mistakenly termed phosphorescence) is the faint greenish glow of phosphorus in the dark. A simple experiment is to form luminous letters by writing with a stick of phosphorus on a sheet of moistened ground glass. The luminous glow of phosphorus is caused by oxidation. Similarly the oxidation of pyrogalllic acid and other substances when mixed with hydrogen peroxide and formalin leads to a bright red glow, which, however, is somewhat transient. Very little has been written about these chemical effects and they afford a fascinating field for experiment.

The light emitted by various insects and organisms is presumably of purely chemical origin. Glowworms in the British Isles emit green light but there are tropical fireflies yielding red light and other creatures emitting light of other colours. Some attention has been devoted in the United States to the chemical processes producing these luminous effects. Professor Newton Harvey has succeeded in reviving luminous effects in organisms after it had lapsed for a considerable time. The separation of these products should yield useful information and might possibly lead to the development of synthetic luminous material. If the duration of the effect were sufficient, even if relatively weak in intensity, it would be useful—for instance for the names of streets and direction signs for which a simple and inexpensive material visible in the dark has long been sought. The practical difficulty hitherto has been that all such materials have proved either too costly or requiring too frequent renewal. On the other hand this method of producing light is probably far more efficient than incandescence, on which most artificial illuminants depend, owing to the fact that apparently no non-visible radiation is emitted.

Many materials will glow brightly when immersed in liquid air. Fluorescence may also be produced by friction. Mr. Harrison Glew has given a long list of crystals which have this property (quartz, fluorspar, naphthylamine, etc.), possibly associated with electrification. The tinder-box and its modern development involving the use of the mineral "cerite" to ignite petrol vapour are possibly instances of the same effect, though in this case the sparks must produce appreciable heat as well.

Radium Compounds.

Let us now turn to a form of fluorescence which has already had very many applications, the excitation of luminosity in zinc sulphide by means of radium emanations, illustrated in the familiar use of this material for the figures on the dials of wrist watches. The initial brightness of the material is roughly proportional to the percentage of radium compound, but as more intense bombardment of the zinc sulphide results in more rapid decay in the brightness, it is clearly desirable on this ground, as well as from the

standpoint of expense, to make the radium content as small as possible. The decay in brightness is due to the destruction of the responsive power of zinc sulphide. It is true that the power of the radium is also diminishing, but this change is so gradual that for practical purposes it may be left out of account. No one has yet been able to find a method of restoring the light-giving power of the zinc sulphide, once it is destroyed. The only thing feasible is to extract the radium and use it again with fresh material. During the war protracted tests were made by the author and others with a view to determining the relation between percentage of radium and rate of decay of brightness. A curious fact is that for a short time after the material is prepared there is an increase in brightness. But thereafter the brightness steadily decreases. In the case of a mixture of 0.1 mg. of radium bromide per gm. of composition the loss in brightness during one year is of the order of 50 per cent. of the maximum value. In some respects this is one of the most hopeful lines of investigation. The material is easily handled and a steady brightness of relatively long duration is obtained. The obvious difficulty is the cost of the radium, and at present there is not any alternative cheaper excitant in view. But it is always possible that some much more highly responsive luminescing material might be found, enabling a smaller percentage of radium to be used. During recent years appreciable advances both in the capacity for brightness and resistance to bombardment of zinc sulphide have been made. At present it appears to be much the best substance for the purpose, though there is still room for experiment. The preparation of the material is a job for the expert chemist, but the experimenter working on a small scale could obtain a supply of weakly luminous compound for a few shillings. The mixing of the powder with mastic varnish for application as paint is not difficult and only requires a little deftness in manipulation.

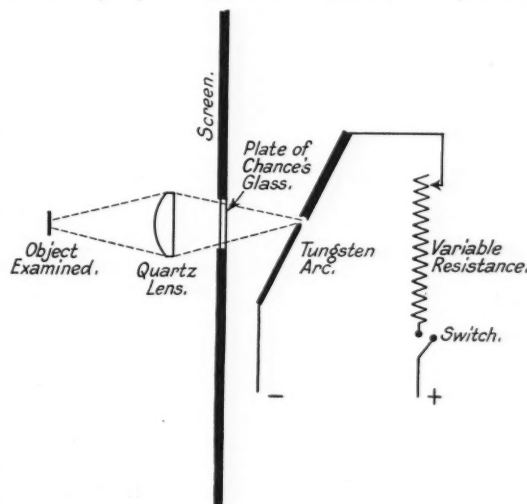
Simple Materials.

There are other means of exciting luminescence. Amongst these may be mentioned the exposure of materials to cathode-rays and X-rays. Screens used for the latter work may be coated with barium platinocyanide or zinc sulphide—both fluoresce a vivid green. In either case the material should be prepared to fluoresce only, not phosphoresce. It is clearly inconvenient that the image should persist when an exposure is finished and the screen is needed for a new picture. Here again there is an opening for research on more sensitive material for screens. In some forms of work the bodies studied are so dense, and the

transmitted energy so feeble, that photography must be used. This applies especially to the study of masses of metal (e.g. searching for hidden flaws in iron castings). The process would become much more simple and expeditious if a fluorescing screen could be used.

Ultra-Violet Rays.

In general it is only the physicist and the technical worker who have X-rays at their disposal. But there is one source of excitation, the blue, violet and ultra-violet rays in the spectrum of the sun and sources of artificial light, which are within the reach of everyone. It is probable that almost all materials would fluoresce to some extent if exposed to ultra-violet light of sufficient intensity and even the blue and violet visible rays have an appreciable effect on many substances. According to the late Professor Silvanus P. Thompson a material which, after exposure to light, would glow in the dark, was first prepared by a shoemaker in Bologna, Cascarole by name. By partial calcination of "heavy spar" (barium sulphate) he produced



APPARATUS FOR PRODUCING ULTRA-VIOLET LIGHT FOR SPECIAL FLUORESCENCE EFFECTS.

The lens is useful for examining special small objects which require intense excitation but can be discarded when larger areas are to be illuminated.

the so-called "Bologna stone." In these days we can obtain materials which fluoresce and phosphoresce much more strongly. Of these the most readily obtainable are specially prepared calcium sulphide and zinc sulphide, the former phosphorescing with vivid blue light, the latter in general green. A sheet of cardboard painted with these materials will glow for hours after exposure to sunlight and even exposure to an ordinary electric lamp produces quite a marked effect. Unfortunately the phosphorescence excitable even in the most sensitive materials is too feeble and

transient to be of great practical value, though occasionally in dark surroundings, e.g., in the galleries of mines, they have proved useful. At one stage of the war it appears to have been a practice to coat gunsights with this material, though later the radium paint was substituted. Excitation in some cases was effected by exposing the material to burning magnesium wire, which is exceptionally rich in ultra-violet rays. The range of colour obtainable with phosphorescent materials, if a powerful excitant (such as an arc between tungsten electrodes or a quartz tube mercury vapour lamp) is available, is considerable. Calcium sulphide gives blue, zinc sulphide green, and, by special preparation, also red and yellow. It is possible to paint a picture on white cardboard indistinguishable by ordinary light but glowing in vivid colours after exposure in a darkened room.

How to Experiment.

In the case of fluorescence the range of colour and degree of brightness are both much greater. In studying these effects it is naturally necessary to exclude visible light, by interposing a screen allowing only the ultra-violet, and possibly a small portion of the extreme violet to pass. The best effect is naturally secured by using a source rich in ultra-violet light (such as those named above) equipped with a plate of Chance's special glass, opaque to visible rays but transmitting the ultra-violet. In examining small specimens for which very intense excitation is needed, a quartz lens to focus the arc on the material tested is also useful. Simple and comparatively inexpensive apparatus of this kind can be run off an ordinary lighting circuit. For work with certain of the commoner materials, for instance, zinc sulphide, the writer has found that sunlight, or even the light from a gas-filled electric lamp, filtered through deep blue glass of the ordinary variety will serve. One can, for instance, readily show by this means the properties of certain varieties of glass in completely checking the passage of ultra-violet rays.

Applications.

Many interesting applications of fluorescence may be noted. As, by using sufficiently powerful light, almost all materials can be made to fluoresce appreciably, we have a new weapon for analysis. Thus, by the colour of the fluorescence one may distinguish spurious precious stones from genuine ones. Different varieties of pearls and diamonds from different fields may be distinguished in the same manner. It appears, however, impossible at present to detect a Japanese natural pearl from the cultured variety by this means. Writing in certain solutions is indistinguishable by

ordinary light but at once apparent when exposed to ultra-violet rays. It has been suggested that the genuineness of bank-notes and important documents might be guaranteed by means of secret designs in fluorescing material. Many oils and fats can be distinguished by this means; possibly (though the writer has not tried the experiment) one could thus discriminate butter from margarine!

Yet another possible application is in philately (stamp-collecting). The collector has always to be on his guard against stamps that have been "cleaned," i.e., a fiscal obliteration removed by chemicals. Very probably such inscriptions would be revealed by strong ultra-violet light. It might even be possible to detect when a stamp has been invisibly repaired, by observation of the junction of paper cunningly grafted on—a device which, if skilfully performed, is difficult to detect with certainty except by boiling the stamp in water, when it comes to pieces! No doubt the persistent experimenter with ultra-violet light would quickly discover other possible applications.

All these effects can be observed with relatively simple apparatus and offer a fascinating field for study. But whilst the experiments may be simple the underlying theory appears complex. It is possible to prepare samples of zinc sulphide which will neither fluoresce nor phosphoresce, others that are excellent for showing phosphorescence but quite unsuitable for use with radium compound, and to modify within wide limits the colour of the phosphorescence and the duration of the effect, all the samples having an apparently identical chemical composition. The explanation must presumably be sought in the arrangement of the electrons within the atom. It is possible that some of the work now being done on atomic structure and the theory of electrons may have a profound influence on the sources of artificial light of the future. It has been remarked that if the candle had been invented during the present age of gas and electricity this simple self-contained lighting unit would have been hailed as a wonderful discovery. If one could go a step further and produce, say a glass sphere containing material which would emit a steady light, independent of combustion processes or extraneous energy, this would prove of the greatest utility, even if the actual candlepower furnished were relatively small.

Finally, just as we have as yet no convenient means of storing alternating current, so we have failed to find any method of storing light on a large scale. Some day we may succeed in collecting surplus solar radiation during the day and applying it usefully to illuminate our rooms after dark.

Treasure Island Looted.

R. L. Stevenson's masterpiece exploited by an American writer of magazine serials after a talk with Lloyd Osbourne, Stevenson's stepson.

It will come as a shock to lovers of R. L. S. to learn that an American writer has calmly turned out a five-part serial story called "Porto Bello Gold" which is the story of how Long John Silver, Bann Gunn, Darby McGraw, Bill Bones and Flint got the treasure on to Treasure Island.

Arthur D. Howden Smith, the writer in question, has not made much of a success of the job. There is no magic in his pen and it is curious to note how, when one does fall across an interpolated Stevensonian phrase in his tale—it rings like a trumpet note.

The author, feeling perhaps not quite sure of his own good taste in the matter, writes the following explanation to the editor and readers of the American magazine *Adventure*, which published his enterprising work:

"The principal point of interest, however, aside from any intrinsic interest in the story itself, must hinge upon the connection with Stevenson and 'Treasure Island,' and I can hear the people I referred to denouncing me as impertinent, and perhaps as a plagiarizer, for assuming to identify myself with what has been called the greatest story of maritime adventure in our language—with which last sentiment, by the way, I thoroughly concur.

His Explanation.

I will take up the Stevenson connection first—to explain it, mind you, not to defend it. When I started to write the story I was reasonably sure that its plotting involved no legal violation of copyright, and I soon made certain of this. But I was not satisfied with this; I didn't want to place myself in the position of having someone write and say: 'Oh, yes, Smith has kept within the law. You can't touch him. But what a yellow, cheap-john trick it was for a chap like him to loot the brain-product of a great artist!' In other words, I was interested in establishing the ethical justice of my position. So I went to the one person alive to-day who has a right to speak for Robert Louis Stevenson, his step-son, Lloyd Osbourne, for whom 'Treasure Island' was written and to whom it was dedicated. Mr. Osbourne is the sole surviving representative of the Stevenson estate; the copyrights, I understand, vest in him. But more important than that, he represents our most valid connection with the Stevenson legend.

I put the question frankly to Mr. Osbourne: 'Would you have any objection, ethical or legal—I don't think your legal objection could hold, but that's neither here nor there, because your ethical objection would be sufficient—to my writing a story which will tell how the treasure got on Treasure Island? Understand, Mr. Osbourne, an objection from you on either ground will be sufficient. I don't choose to place myself in the position of doing anything which you, as representative of R.L.S., might feel called upon to denounce as an insult to his memory.'

Mr. Osbourne answered me equally frankly: 'I haven't the slightest objection. I think it's a wonderfully whimsical idea, and I hope you do a fine story. After all, you know, you can't hurt "Treasure Island" by writing a bad story, but on the other hand, if you write a good story, you'll be helping "Treasure Island" as well as yourself. Good luck to you.'

And that's that. I ought to add that our conversation was oral, and the record I have made of it is according to my recollection. It is substantially accurate, I think.

Prophet's Mantle.

Of course, 'Porto Bello Gold' is not, nor does it pretend to be, Stevenson's story in any particular. It is, structurally, entirely my own, with the possible exception that I have availed myself of certain situations, which Stevenson in 'Treasure Island' refers to most sketchily, for salient episodes in my plot. This is especially true of the character and part in the plot of the boy *Darby McGraw*. Stevenson merely makes passing mention of him in the description by one of *Flint's* crew of *Flint's* death. I built up *Darby* practically from that one line. And in my story, you will note, he supplies the psychological interest which the boy *Jim* supplies in Stevenson's story—that is, the reactions of a boy to the glamour and realities of pirate life.

Flint, too, is as much mine as Stevenson's, for you will all remember that he does not actually appear in 'Treasure Island,' although he is described in some detail. I hope he passes muster. His death scene is built up from the same passing reference which I mentioned above. And it is a tribute to the essential greatness of Stevenson, an indication of his mastery which makes the work of the rest of us so feeble by

comparison, that he was able to paint the picture of *Flint's* death to suit his especial plot needs in that one, raw, splashing phrase: 'Fetch aft the rum, Darby McGraw!'

There is a bit more relating to the author's own hero and heroine and various characters apparently left over from other magazine serials of his compilation and worked into "Porto Bello Gold."

America is a land of original ideas and great adaptability, but it will be a pity if the habit spreads. There it is not exactly piracy or plagiarism, or grave-robbing, and it is hard to say how Mr. Osbourne tackled by the enterprising promoter could have acted other than he did. His phrase, "After all, you know, you can't hurt 'Treasure Island' by writing a bad story," is significant.

Well, Arthur D. Howden Smith has borrowed Stevenson's characters, island, stockade, names and all, and even with this wonderfully stocked wardrobe has failed to write even a decent yarn of the pirate seas. It will be interesting to see whether any English publisher will test the taste of the British public with it.

H.B.C.P.

Books Received.

- The Real 'Round South America.* HARMAN BLACK. (Simpkin, Marshall & Co. 10s. 6d.).
- The Homer of Aristotle.* D. S. MARGOLIOUTH. (Basil Blackwell. 10s. 6d.).
- The Marine Plankton.* JOHNSTONE, SCOTT and CHADWICK. (Hodder & Stoughton. 12s. 6d.).
- Social Aspects of Psycho-Analysis.* ERNEST JONES, M.D. (Williams & Norgate. 7s. 6d.).
- Ranstead.* SIR HENRY LAMBERT, K.C.M.G., C.B. (Simpkin, Marshall & Co. 2s. 6d.).
- The Lifework of Lord Avebury.* By various Authors. (Watts & Co. 6s. net)
- Modern Languages.* Edited by E. A. CRADDOCK. (A. & C. Black, Ltd. 1s. 6d. net).
- Relativity for Physics Students.* G. B. JEFFERY, M.A., D.Sc. (Methuen & Co., Ltd. 6s. net).
- The Roman Occupation of Gl. Britain.* GEORGE MACDONALD. (Oxford at the Clarendon Press. 18s. net).
- Cambridge Readings in the Literature of Science.* Arranged by W. C. DAMPIER WHETHAM and MARGARET DAMPIER WHETHAM. (Cambridge at the University Press. 7s. 6d. net).
- Human Physiology.* C. G. DOUGLAS, C.M.G., F.R.S., etc. and J. G. PRIESTLEY, M.C., D.M. (Oxford at the Clarendon Press. 12s. 6d. net).
- The Microscope.* CONRAD BECK. (R. & J. Beck, Ltd. Part I, 2s. 6d. Part II, 7s. 6d.).
- The Evolution and Distribution of Fishes.* JOHN MUIRHEAD MACFARLANE, D.Sc., LL.D. (Macmillan & Co. 25s. net).
- A Long Life's Work.* SIR ARCHIBALD GEIKIE, O.M., K.C.B. (Macmillan & Co. 18s. net).
- Instrumental Methods of Chemical Analysis.* WILLIAM N. LACEY. (Macmillan & Co. 7s. net).
- Charlie Mackintosh.* HENRY COATES, F.S.A.Scot. (T. Fisher & Unwin, Ltd. 3s. 6d. net).

Correspondence.

To the Editor of DISCOVERY

DEAR SIR,

I have been a subscriber of the little Journal DISCOVERY since the first issue, and have them all carefully put away.

Living in the "back-blocks" four hundred miles from Sydney, twenty-two miles from the nearest railway, two mails a week on a sheep station, the little journal has given me untold pleasure.

It was with sadness I read in the December number that it was to be no more. However, it was a very happy surprise to find it has a new lease of life and I hope it may long continue, and will do my best to get some new subscribers.

The articles on "Dowsing" are very interesting. The Divining Rod as it is commonly called is very much used in this part, being subject to prolonged droughts, the average rainfall being less than 19 inches per year, and some years less than 8 inches. All permanent water supplies have to come from below. So the "Rod" is very much used, for locating wells and bores, some of the latter are 2,000 feet deep. Owing to the dryness of the climate it is most suitable for growing mutton and wool, from which we make our living.

You asked for subscribers to state what most interested them in the Journal. I loved all the writings on Psychology, Biology and the Origin of Life, and the Reviews of New Books are splendid.

Having derived so much pleasure from the little journal, I thought I'd like to be amongst the number who wrote their appreciation of it. Wishing it long life, I remain, yours sincerely,

FLORA A. MUNRO.

WOODSIDE WARREN, NEW SOUTH WALES, AUSTRALIA.

25th March, 1924.

ALCOHOL SOLUTIONS.

THE disinfecting power of alcohol has long been realised and utilised, but it is not generally known that a 70% solution has a greater bactericidal action than "absolute." The reason for preferring the weaker solution is that pure alcohol tends to coagulate the surface of albumens without penetrating to great depths and that in some cases bacterial processes proceed within the thicker masses of specimens so treated.

The 70% solution is the best critical value as a rise to 80% or a drop to 60% means a loss of some thirty times the value of the substance as an immediate bactericide.

* * * * *

Solid hydrogen has been experimentally produced by the U.S. Bureau of Standards. The temperature was estimated as minus 437 degrees Fahrenheit. Serious difficulties have previously been encountered in producing the solid form from the liquid gas, for any impurities present tended to solidify first and clog the delicate apparatus employed.

The Baby Killing House-Fly.

Our cover block this month shows a micro-photograph of a common house-fly. If the brutes were this size they would long ago have been exterminated. May this be a timely reminder to you to wage such war against the pest as is possible. Inspect your own dustbins first.

WE are nearing the time of year, when, with disconcerting regularity, the number of infant deaths very greatly increases. The immediate cause of this increase is well known; it is due to an acute epidemic form of diarrhoea and vomiting. But the cause of this epidemic is, from the point of view of prevention, the only important question. It has been found that the number of infant deaths increases very rapidly as soon as the temperature of the earth at a short distance below surface level reaches a certain minimum. Last year, for instance, was much colder than usual; and the death rate among infants was accordingly one of the lowest on record.

The temperature of the earth below the surface depends, of course, on a prolonged spell of hot weather. And, whether or no, it be the only culprit, the common house-fly is certainly a big factor in this serious periodic death of babies. The hotter the weather, the greater the number of flies.

Plague of Modern Egypt.

A convincing proof of the truth of this statement is given by Dr. E. H. Ross in "The Reduction of Domestic Flies." (John Murray, 1913). In 1909, in Cairo, there was a repetition of the Biblical death of the first-born, which closely followed the plague of flies. Flies, it is true, are a constant plague in Egypt, where blindness is exceedingly common owing to the superstitious fear of mothers of brushing away flies from their babies faces. But in 1909, a very exceptional year, rain fell in April. Shortly afterwards the temperature rose to 102° in the shade, and flies increased to an unprecedented extent. In two months 3,000 infants died of intestinal diseases.

The habits of the fly explain this relationship. During the South African war, in which many thousands died of enteric fever, the latrines were frequently disinfected with iodoform powder, which is bright yellow. It was noticed that all the flies in the surrounding camps carried iodoform powder on their legs. The bacilli which cause intestinal diseases, both in adults and infants, are naturally abundant in latrines and similar refuse. A glance at a micro-photograph of a fly, with its countless short hairs and sticky pads on its legs, will immediately show how admirable an instrument it is for the dissemination of bacilli.

The proof that flies carry bacilli is easily obtained. By making them walk on bacteriological culture plates

it has been found possible to grow the organisms which cause typhoid fever, infantile diarrhoea, cholera, dysentery, and many other diseases.

Many animals, birds and insects live on flies, but the effect which they have in reducing their numbers is very small. The fly breeds exceedingly rapidly in hot weather, and is in great measure protected from its foes by its close association with human beings. In this country birds do not come into the house to feed on them, although in Palestine I have seen fly-eating birds in my tent on many occasions, and have even sat while they perched on my head and eat the flies that also perched there in their thousands.

Counter Measures.

The only way to reduce flies, therefore, is to destroy their breeding places. This plan has proved of international importance in the destruction of the mosquito; the Panama canal could never have been built but for the determined extermination of the malarial and yellow fever mosquito. It is probable that the house-fly takes a heavier toll of human life than the mosquito every year. We are certain that many fatal diseases are spread by it; it is probable that all diseases due to bacilli may be carried by it. In Khartoum to-day, malaria is practically unknown. It is an offence punishable by a fine there to allow a pool of water on any private property, and the extermination of the mosquito has followed.

A similar method should be followed in England. All refuse and garbage heaps, all primitive sanitary arrangements should be strictly supervised. *Paraffin oil, sprinkled over a refuse heap, will effectively prevent the fly breeding, and if possible all garbage should be burnt. Moreover, all dust-bins should have a closely-fitting cover.*

If the fly caused half as much damage to the pockets of the community as it does to its health, it would long ago have been exterminated. Such is the tragic rule in human affairs; the only way to hurt a man is through his pocket. It required the sinking of capital in the Panama canal to make it worth while to render them healthy. And it would seem that only the infliction of heavy fines on those who permit breeding ground for flies to remain on their property can stop this disastrous annual plague among young children.

R.J.V.P.

The Present Status of the Evolutionary Theory—III.

By Lancelot T. Hogben, M.A., D.Sc., F.R.S.E.

In the concluding article of this important series Doctor Hogben reviews contemporary and past theories in relation to the results achieved by modern experiment. More knowledge is needed about the origin of variation before certain existing hypotheses can be accounted verified.

THE foregoing essays of this series have been concerned solely with a survey of recent experimental investigations the results of which are accredited by the testimony of independent workers. In what follows the views expressed are those of the writer of the present article, and it will be wise to state at the outset that many eminent biologists of to-day would disagree profoundly with some of the conclusions which are put forward. In considering the rise of the evolutionary hypothesis it is advisable not to overlook two significant facts. One is the extraordinary paucity of accurate information concerning the reproductive processes which the generation of Darwin had at their disposal. The other is the natural reaction produced by intense opposition on the part of the church and the inevitable degradation of scientific discussion when forced to fight prejudice and emotionalism on their own ground. While there is no need to suppress a tribute to the moral courage and mental vigour of pioneers like Huxley, there is good reason to recognise that the biologist in fighting for the right to speculate freely along his own line of enquiry sometimes substituted the appeal of the parliamentary candidate for the detachment of disciplined thought. In consequence what was in reality a good debating point came to pass as the currency of scientific reasoning. One can understand that the public must have been immensely amused when told that the bishop himself had at an earlier stage in his career, gill arches like those of a dogfish. But when the citation of embryological descriptions passed into zoological textbooks as proof of the truth of evolution it may be questioned whether the advancement of truth was not sacrificed for the exigencies of propaganda.

Evolution and Experiment.

The fact that organisms frequently display in their embryonic life structures reminiscent of the adult forms of animals which existed on the earth at an earlier period was, and is still in some quarters seriously urged as an especially cogent argument in favour of the evolutionary hypothesis. If experimental breeding justified the inference that a new type recapitulates in its own life history the characters of the parental stock from which it differs, the observed fact that

developmental stages in the life of an organism frequently resemble adult forms which were antecedent in the time process would constitute a cogent consideration for regarding such antecedent forms as ancestral to it. This is, however, not the case. If a bare-necked fowl appears as a sport in an ordinary breed, it does not start as a chick with hackle feathering: it is bare-necked from the beginning. Hence it is perfectly evident that the phenomena of "recapitulation" interesting as they may be to the systematic zoologist, do not add anything specific to the evidences of evolution.

Evolutionists of the Victorian epoch were as Bateson insisted, seeking the living among the dead. The final proof of evolution does not rest with geologists nor can it be vindicated by the microscope. It is an experimental issue. It depends upon our understanding of the hereditary mechanism. And exact knowledge of the hereditary mechanism begins in the opening years of this century with the application of Mendel's method. Admittedly the factorial hypothesis does not attempt to account for the origin of genetic diversity, though Mendelian analysis has brought us into closer contact with the appearance of new hereditary types in nature.

Hereditary and Variation.

It is primarily concerned with the mechanism of heredity by which the specific characters of the organism are conserved rather than the mechanism of variation by which the specific characteristics of the organism are modified. What it has contributed pre-eminently to the development of the evolutionary theory is a clearer recognition of the distinction between these two aspects of the study of inheritance. A wild *Drosophila* transmits the red coloration of the eye or the gray coloration of the body with regularity and precision. When by a change in the constitution of the gametes brought about by influences which the factorial hypothesis makes no attempt to identify, there appears a mutant offspring with white eyes or black body color, the recessives of the F₂ transmit the new factor with the same regularity and (precision) if mated among themselves. To the biologists of a previous generation the terms heredity and variation denoted but two aspects of a single process, co-exten-

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sive with one another. And because they utterly failed to make a clear distinction between these two fundamentally distinct problems of inheritance, they attached an undue importance to the part which certain influences have played in evolution. The conception of Natural Selection as understood by Darwin is so pervaded by the failure to distinguish between heredity and variation that it provides little that is constructive material for a modern presentation of the evolutionary hypothesis.

Darwinian biologists used the term variation to cover all differences between offspring and parent, and as no two generations are absolutely similar, variation and heredity necessarily appeared to be co-extensive. But it is evident that since the characters of an organism represent the end product of a long series of reactions into which environment factors enter at every stage, differences between parent and offspring are not necessarily variations in the genetical sense. That this is so is clearly established by considerations other than those derived from Mendelian experiments, more especially from what is known as the study of pure line inheritance, i.e., uniparental inheritance among parthenogenetic animals and self-fertilising plants. The very careful investigations of Johannsen (1909) in particular call for brief comment in this connection. Johannsen studied inheritance of seed weight in beans. If we take a mixed population of beans and weigh them, the majority will probably not be found to diverge considerably from the average weight of the population as a whole; we find a constantly decreasing number of individuals as we approach the upper and lower extremes of weight, and a curve in which seed weight is plotted against frequency will, in general, be of the same form as a probability curve. On selecting an individual of a seed weight above or below the average and allowing it to germinate and seed by self-fertilisation, we obtain a frequency curve of the same shape on plotting the seed weights of the progeny. But the average may be greater or less (as the case may be) than for the original population as a whole. When the individuals of such a "pure line" are selected and selfed, their progeny, on the other hand, give a frequency curve with the same maximum whether we select the heavier, lighter, or average seeds. The curve of variation of the population as a whole is compounded of a series of curves, showing the variability of a number of genetically different strains. The variability within such a strain or "pure line" is not of genetic significance, inasmuch as whatever individual we select within these limits yields progeny showing the same average and the same range. Selection in a mixed

population consists in isolating pure types. When that has been achieved no further improvement can be effected by selection alone. We have thus to discriminate between genetic variability which is discontinuous and somatic or fluctuating variability, which is continuous. By somatic variability we imply those differences between parent and offspring which are due to differences in their environment.

Succession and Evolution.

In the introductory essay of this series particular emphasis was laid on the distinction between *succession*, the progressive differentiation of living types as they have spread over the world's surface in the course of past ages, and *evolution* an hypothesis which interprets this succession in terms of the ordinary course of reproduction. It has been pointed out that this hypothesis must stand or fall with the adequacy of our knowledge of the reproductive mechanism to account for the genetic discontinuity observed among living organisms. This discontinuity manifests itself in two forms which it is desirable for the present to consider as separate issues.

First there is structural discontinuity. Animals differ in innumerable characteristics for which they breed true when bred with their like. Thus Manx cats if interbred produce offspring which differ from most other cats in the absence of a tail; white-eyed strains of *Drosophila* yield white-eyed progeny; Buff Orpingtons when bred among themselves have chicks characterised by the peculiarities of the breed. We may say at once that the observations which have accumulated through the study of inheritance by the Mendelian method have left no difficulty as to the origin, persistence and accumulation of structural differences in the history of animal life. Before Mendel, investigators in hybridisation had considered the individual as the unit for study, hence arose the belief that hybrids are intermediate between the parents, and this belief in its turn engendered the notion that the crossing of a new type back to the parent stock would involve a dilution of the new character, culminating after a number of generations in swamping it out of existence altogether. Evolutionists of the Darwinian period therefore introduced a variety of devices, such as geographical isolation and the survival of the fittest, to obviate the effect of this swamping and account for the persistence of new types. Thus to Darwin's generation it seemed that without selection there could be no evolution; the new type would always be swamped out of existence in the long run. We have seen that though the first generation of the cross may appear intermediate between the parental types, both

parental types appear in their original purity in the next generation, and will continue to breed true to type when mated among themselves. Darwin's comparison between natural selection and artificial selection is as legitimate as it ever was—as a comparison. But Darwins' view of how natural selection operates was unfortunately compromised by his ignorance of what really happens in artificial selection. All selection does is to eliminate. The elimination may emphasise or exaggerate the discontinuity of animal or plant forms, but it does not condition that discontinuity. The preservation of new types must be attributed, as far as experimental evidence permits us to judge, to the nature of the hereditary mechanism.

Selection is Elimination.

A character once it has appeared, persists in virtue of the segregation and integrity of the hereditary factors by which it is determined in the germ cell cycle. In other words there is no longer any need to invent an external mechanism to preserve structural differences between living organisms once a new type has arisen. We know that new types do arise, and having arisen their continued existence is assured by the nature of the hereditary mechanism unless they are incapable of surviving. The term Natural Selection thus implies two propositions, one of which is self evident and the other an elaborate argumentum ad hominem based on premises which cannot to-day be regarded as having any foundation in fact.

From this standpoint the experimental postulates of the evolutionary theory have been considerably reinforced by modern work. But structural discontinuity does not exhaust the extent of diversity among living beings. There is another problem presented by the *breeding unit*, or species in the Linnean sense. It is best for purposes of discussion to drop the term species which is also used by taxonomists to signify little more than a convenient way of arranging museum specimens on shelves. The differences which prevent members of one breeding unit e.g., the dog and another, e.g. cat freely mating with the production of fertile offspring are various and heterogeneous, and may be associated with profound or only very slight structural differences. In some cases the barrier is simply a structural one; a small difference in the copulatory appendages prevents successful congress. But a single breeding unit, e.g., the fowl, *Gallus domesticus*, may comprise an extraordinary range of genetic diversity with such picturesque extremes, e.g., as the Buff Cochins, Yokohamas and Silkies. The barriers which define the breeding unit roughly fall into two categories: (1) members of two units may very occasionally be

induced to mate and then produce fertile offspring; (2) members of two units may mate but produce sterile offspring, e.g., the mule; (3) members of two units may fail to produce offspring at all. That is to say, the breeding unit is defined by the fact that its members shew very low fertility with members of another unit, or produce sterile offspring with members of another unit, or are themselves completely sterile with reference to members of another unit.

Causes of Sterility.

The first of these barriers, low fertility, is one which is readily amenable to experimental study. The inheritance of high and low fecundity has been repeatedly shewn to be amenable to Mendelian analysis. Mutants or sports with relatively low fertility with regard to the parent stock may be presumed therefore to arise like any other character which depends on unit factors in the chromosomes. The second constitutes a special case. In the case of the mule it has been shewn that the sterility is associated with the failure to form gametes on account of the difference in the size and number of the chromosomes in the two species; and we actually have experience of mutations in which the chromosomes numbers are multiples of the chromosome number of the parent stock ("triploids," "tetraploids" etc.). As to complete sterility an interesting suggestion has recently been put forward by Crew (1923). It has long been known that two factors may interact to produce characters which are not like those produced when either is present alone. Thus there are strains of white sweet peas which though each pure for white when crossed produce colored offspring. They carry "complementary" factors for color, the presence of which is inferred from the conditions which occur through these interactions. If a form that was completely sterile towards the parent stock were to arise in the ordinary course of things, it would necessarily, unless hermaphrodite, die without issue. However, if two forms arise which bear each respectively a factor which in the presence of its complement of the alternate mutant produces a lethal condition, such forms though incapable of interbreeding would mate freely with the parent stock and constitute separate breeding units with reference to one another. This interpretation has been put forward by Crew to account for the production of monstrous calves by inbreeding among Dexter cattle.

Breeding Factors.

To sum up, the study of inbreeding, self-sterility among hermaphrodites and fecundity among domestic breeds amply justifies the view that sterility and other physiological barriers to free intercourse are capable

of being inherited according to the Mendelian and chromosomal hypothesis. A host of circumstantial evidence points to the conclusion that the barriers which define species in the Linnean sense follow the Mendelian law—for example the incidence of disturbances in the sex ratios of species hybrids with reference to the heterozygous sex, which, as Haldane points out, (1922) would be expected if sex-linked factors were involved. There is a hopeful outlook for the future of evolutionary theory. As the study of inheritance is freed from obscurantist speculations of collectors and made the subject of quantitative experiment there vanishes "the crude belief that living beings are plastic conglomerates of miscellaneous attributes and that order of form or Symmetry have been impressed upon this medley by Selection alone, and that by Variation any of these attributes may be subtracted or any other attribute added in indefinite proportion." The evolutionary problem presents itself in new form as our knowledge of the hereditary mechanism develops. The final justification of the evolutionary argument will be achieved when intersterile mutants have been shewn to appear under experimental conditions. We shall then be able to say that new types which display not only structural by syngamic discontinuity have arisen in the ordinary course of generation. At present it is only possible to say that we have very good reason to believe they can do so.

Knowledge Needed.

Scientific hypothesis may be classified according as they permit us to make *verifiable* predictions about future events or merely serve to stimulate enquiry and suggest possibilities for further investigation. In the first category, for instance, we may place the theory of electrolytic dissociation. To this hierarchy of scientific doctrine the evolution theory has not yet attained. It will not do so until we know something more about the origin of *variation*. At present we are equipped with insufficient knowledge even to speculate profitably concerning the mechanism by which new germinal types arise. To the view that bodily modifications can impress themselves on the germ cells so that the latter reproduce them in succeeding generations, we may safely apply William of Occam's razor. As even the most fervent Lamarckian cannot point to one single critical experiment on the inheritance of acquired characters which has been performed with uniform results by independent investigators, there is no need to assume that acquired characters are inherited. As there is no need to infer the inheritance of acquired characters, we may best preserve the economy of scientific hypothesis by leaving the

Lamarckian principle out of our discussion. It has sometimes been urged that inheritance of acquired characters must occur because evolution could not be satisfactorily explained without it. There seems to be no adequate reason to justify the statement that evolution cannot be satisfactorily explained without assuming the inheritance of acquired characters. But if there were, it would not be an argument in favour of the Lamarckian principle so much as an argument against the Evolution theory since it would imply that the truth of evolution depends on assuming a mechanism for whose existence we have insufficient evidence. Whether the Lamarckian principle as stated by Guyer and Smith (1921) or Kammerer can be justified will depend on whether among those who repeat their observations some are fortunate in recording the same experiences. The "Neo-Lamarckian" view that acquired characters gradually become impressed on the hereditary constitution only after countless generations transfers the issue from the plane of verifiable experience to one of pure surmise, rendering further discussion meaningless. While the origin of genetic variations remains a question for physiological analysis, new horizons open up with the increasing recognition that similar mutations appear again and again in allied breeding units.

Men are impatient of the discipline which scientific method imposes; As Trotter comments "In matters that really interest him, man cannot support the suspense of judgment which science so often has to enjoin. He is too anxious to feel certain to have time to know. So that we see of the sciences, mathematics appearing first, then astronomy, then physics, then chemistry, then biology." For the real history of any science begins when quantitative observation supercedes purely qualitative description. The evolutionary theory is still in its infancy. It is becoming more and more the nucleus of a living body of experimental investigation. Perhaps when the history of the evolution theory is written a century hence, Bateson's "Materials for the Study of Variation" will assume a more prominent place in its pages than "The Origin of Species," and the name of Thomas Hunt Morgan will emerge more prominent than that of Charles Darwin.

Engineer Captain E. C. Smith, O.B.E., R.N. (ret.), who is well-known as a lecturer and writer on the history of Engineering has been appointed Guide Lecturer at the Science Museum, South Kensington.

At present only the collections which are exhibited in the Old Buildings, Aeronautical Collection, and selected groups of the Science Collections are available, but as galleries of the new Museum building are completed and occupied the conducted tours will be extended to these also.

Book Reviews

The Philosophy of Music. By WILLIAM POLE, F.R.S., Mus.Doc. (Oxon). Edited by Kegan Paul.

This is an excellent book and its re-issue should be welcomed by all who take more than a superficial interest in music. Especially should it appeal to those of a musical or scientific frame of mind who may often have pondered upon the why and the how of things musical without reaching a satisfactory conclusion. The ordinary text-book of Harmony or Counterpoint throws little light upon the fundamental questions, assuming them axiomatic, and it has hitherto been necessary to delve pretty deeply into the works of Dryasdust if one sought for information about the elementary material of music. But Dr. Pole possessed not only a wide knowledge of these matters, but also an attractive style, and this combination has enabled him to set them forth clearly and sufficiently completely to give the general reader a fair all-round grasp of the subject.

Prospective readers should, however, be warned to look before they leap. There must be many who feel, when they look round on the chaotic condition of contemporary music, that the art stands in urgent need of a Philosopher who will give a basis and a direction to all the effort which is being expended upon it. For him we have still to wait. Dr. Pole is not a philosopher in this sense. His work first appeared in about 1895, and at that time, as Mr. Edward Dent points out in his Introduction the word "Philosophy" bore a connotation somewhat wider than that which obtains to-day.

It would be unreasonable, perhaps, in any case, to expect an important contribution to modern musical aesthetics in a book thirty years old. But apart from his use of the word "Philosophy" (where we should perhaps prefer "Natural Philosophy") it is surprising how little the passage of time has affected its value. Mr. Hamilton Hartridge has contributed a supplementary essay to this edition in which he embodies the advances that have been made in the subject since Dr. Pole wrote. The brevity of this essay and the comparatively unimportant matters with which it mostly deals are facts that speak for themselves. The explanation is not far to seek. The original author confined himself almost entirely to scientific and historical matters, and these, as he points out, are far more stable than any æsthetic theory. His own book indeed affords an illustration of this. The few places where we feel inclined to disagree with him are almost invariably those where he ventures on some musical as opposed to scientific opinion. In his chapter on "Counterpoint," for example, we find the following:—"It is doubtful if any musician now alive could write a motif which should be mistaken for Palestrina, or a madrigal which could be attributed to Luca Marenzio, or a Church anthem like one by Orlando Gibbons, or a chorus like one of Handel's, or an organ fugue like one by Sebastian Bach." We should hardly consider that a doubtful proposition to-day, when we are perhaps in a better position to estimate the achievements of those masters. It is interesting to notice that this is the only mention of Bach in the book, although the author gives an otherwise full account of the meaning and origin of "equal temperament." Apart, too, from this allusion to Orlando Gibbons not a word is said about the English Tudor composers, although their foreign contemporaries are referred to more than once.

These points of detail in no way compromise the value of Dr. Pole's work. They are isolated remarks, he bases nothing on them, and his main conclusions are unaffected by them. He starts by considering the "material of music," the physical basis of sound and of musical sound in particular. This brings us in due course to the harmonic series. Part Two deals with "Elementary arrangements of the material," intervals, scales, modes, tonality, and so on, and includes incidentally a short but admirable review of musical theory from Pythagoras to modern times. The vexed question of the Greek modes is not shirked, though Dr. Pole would perhaps be considered a little arbitrary nowadays in the way he puts forward the explanation he favours and ignores all others. He is probably right about Greek scales subsequent to Aristesunus, but the earlier theory and practice is still a very open question. The Third Part of the book deals with the "Structure of music," melody, harmony, and counterpoint. It is in no sense a text-book for students of composition, but sets out to show how far the laws of the art of composition are founded on a scientific basis and how far they are the result of purely æsthetic considerations.

It will be a pity if Dr. Pole is not widely read by students. He solves such a number of problems that they should be interested in. What exactly is sound? How is it produced, transmitted and received? Why should the tone of a violin be different from that of a flute, trumpet, or piano? Why are scales necessary to music, and why has the diatonic scale proved more satisfactory than others? What were the Greek modes? Do they correspond to the ecclesiastical modes of the same names, and if not, how has the difference arisen? What is the real nature of the problem that was solved in one way by "equal temperament"? What is the unique quality about the major common chord which caused the older composers to close with it invariably, even when their music was in the minor mode (the familiar "tierce de Picardi")? To these and many other questions Dr. Pole provides the answers. He may not have given us a "Philosophy of Music" in the present-day sense. But in making a thorough inquiry into the scientific side of the subject in the light of modern scientific knowledge and by presenting the results in an easily intelligible form he has done much to clear the way for the real philosopher of music when he comes along.

The Rhind Mathematical Papyrus. Introduction, transcription, translation and commentary by T. Eric Peet. (The University Press of Liverpool, 1923. Price 63s. net).

The Rhind Mathematical Papyrus, bought by Mr. A. H. Rhind at Luxor in 1858, is in the British Museum and consists of two papyrus sheets numbered 10057 and 10058, which originally belonged to one roll but were separated, probably by accident in unrolling, with the loss of a portion, some fragments of which are now in New York.

The papyrus was written at some date between 1788 and 1580 B.C. by one Ahmose, who says that he copied it from an original of the reign of Amenemmes III (about 1849 to 1801 B.C.).

It was noticed by Lenormant in 1867, and in 1868 Br. Birch published a description of it with a few quotations. In 1869 facsimiles were prepared by the British Museum for publication, but they did not see the light till 1898. In the meantime a copy had been lent by Dr. Birch in 1872 to August Eisenlohr, who in

Mr. Conrad Beck is to be congratulated on having produced *The Microscope*, Vol. I and Vol. II (R. and T. Beck, Ltd.). The first volume is a simple handbook at 2s. 6d. net, which is admittedly elementary but is at the same time a veritable godsend to the beginner. It is worth far more than is charged for it and is a sound review of simple work and ordinary apparatus. Well and clearly written and fully illustrated, it can be commended to any student and even more advanced workers.

Volume II is a larger and more expensive book, 7s. 6d. net, but it is worth three times the sum, for it covers all that the most serious of workers needs to know about his instruments and deals so far as may be compassed without advanced mathematics with the whole theory of the instrument and the perfect technique of its use.

The work is an admirable instance of what a man who knows his subject thoroughly from every point of view can do in the way of turning out a book which is a credit to the whole industry as well as to the author. Microscopists in general will be glad to have on their shelves a book by such an authority, and we can say at once that the scope of the work is enormous and not by any means confined to the specific manufactures of the firm of R. T. Beck.

Optics, aperture and resolution, photometry and kindred technical subjects are clearly dealt with, while the microscope user will find the chapters on glare and flooding, illumination and technique, sources of information from which even highly experienced practitioners may yet learn much.

The physicist will find the chapter on microscopes for special purposes a very valuable accessory feature to the book, for it covers a full range of modern applications up to and including the ultra-microscope. It is altogether a book that can be very sincerely and cordially recommended as covering a difficult and complex subject. It is clearly and soundly written.

The Marine Plankton. By JAMES JOHNSTONE, D.Sc., ANDREW SCOTT, A.L.S. and HERBERT C. CHADWICK, A.L.S. With an Introduction by Sir William A. Herdman, F.R.S. (The University Press of Liverpool, 12s 6d. net).

The microscope worker, both specialist and amateur, will welcome this timely addition to the literature of the microscopic life of our British seas. The book covers a period of fourteen years' investigations made daily at Port Eim, Isle of Man, and records not only the species of organisms found in the catches but gives a monthly index of their occurrence and distribution. Apart from its very high value to the specialist the book is an admirable handbook for the student and contains nineteen really beautifully drawn photos from which it is possible to identify some two hundred and fifty moderately common planktonic forms. These drawings represent no mean labour and set a very high standard for less gifted observers to follow, but they enormously enhance its value to the student who so often finds difficulty in identifying some larvae form without a weary search through a mass of none too accessible literature.

The authors unfold a curious sea story, a review of observed conditions and probable causes that is still one of the great fields for research, a scientific mystery of the sea. This minute lowly Plankton with its myriad diatoms and teeming copepods may be the basis on which all the vast life of the sea is built up, may indeed, according to some schools of thought be the very basis from which all life terrestrial as well as marine has slowly risen. The ocean as a food resource increases in importance with the increase of our population, and the development of transport. The practical application of these researches into the minute

life of the sea lies largely in their important bearing on the question of fisheries. We have only recently solved the mystery of the life cycle of the eel. The Plankton may yet hold as fascinating discoveries.

The Moon Element: An Introduction to the Wonders of Selenium. By E. E. FOURNIER D'ALBE D.Sc., F.Inst.P. (Fisher, Unwin Ltd. 10s. 6d. net).

The selenium cell is one of those scientific toys which captivate the imagination of inventors, and since Willoughby Smith in 1873 discovered that its resistance to electricity varied according to the intensity of light falling on it, a mint of money must have been spent on experiments designed to apply this property to a practical use.

For fifty years selenium has been the recognised bridge between optics and electricity and has intrigued not only scientists but inventors of all kinds, both genuine and charlatans.

Mr. Fournier d'Albe's book is excellent so far as his descriptive and historical sections are concerned, and he approaches the whole relation of the undeveloped potentialities of selenium in a stimulating manner. We feel though that there is far too much about his own invention the Optophone, and the rather unfavourable opinion formed of its value by some authorities in practical association with great institutions for the blind.

The interest in the selenium cell lies for the present in its purely scientific applications in photometry, and in the transmission of speech along light beams. True, the perfection of the latter principle may inflict on us talking films, but let us hope the day is long postponed. Television, a subject now greatly in the air, may on the other hand, be of considerable use to humanity. This book gives a valuable popular introduction to all these possible applications of selenium elements and is valuable as bringing together in book form many facts about the application of selenium not readily accessible. A bibliography should have been included.

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The Trustees and Committee render cordial thanks to all those whose help has been recorded in this and the previous list, both for their gifts and for many kind expressions of appreciation of the work of *Discovery*, and they appeal again to other readers and friends of *Discovery* to help them in completing the total of £500 which is needed to establish the Committee's work.

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